Husbandry Guidelines for the Common Hippopotamus

Hippopotamus amphibius

Mammalia: Hippopotamidae

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DISCLAIMER

OCCUPATIONAL HEALTH AND SAFETY RISKS

WARNING

This animal is classified as DANGEROUS and is capable of inflicting a potentially fatal injury.

Caution should be taken when working with the Hippopotamus, *Hippopotamus amphibius*. Keepers are not to work in the enclosure with these animals and are to carry a working two-way radio at all times. There should be two padlocked gates between keepers and these animals when working in their enclosures. There should be appropriate signage on the outside of exhibits and nightyards identifying them as dangerous animals. Hazards to keepers when working with Hippopotamuses fall into several categories; physical, chemical, biological, manual handling, psychological and radiation. These hazards as well as preventative measures are outlined in Table 1.0.

Table 1.0 – Hazards Associated with Working with Hippopotamuses and Preventative Measures to Avoid Injury.

Hazard category	Type of Hazard	Preventative Measures
Physical	Large canine tusks – injury through bite. Large size and speed – injury through crush or trampling.	Keepers are not to work in the enclosure with these animals and are to maintain two padlocked gates between them and the animal when working in enclosures. Thorough staff training.
Chemical	Exposure to chemicals used in cleaning – Wonderclean, Bleach. Medicines for treatment and diet supplements.	Use PPE (Personal Protective Equipment) when handling chemicals and have Material Safety Data Sheet (MSDS) in proximity. Ensure medicines and supplements are labeled correctly and read instructions.
Biological	Zoonotic diseases such as Salmonella.	Always wash hands thoroughly after working with Hippos and after cleaning in their enclosures. Clean and disinfect equipment.
Manual Handling	Design of the exhibit and nightyards, heavy lifting – large volumes of hay and faeces.	Staff training in manual handling.

Psychological	Working with dangerous animals.	Adequate staff training in moving animals.
Radiation	Harm from UV radiation from working outdoors.	Use protective clothing – long sleeved shirts, hats, sunglasses, and wear sunscreen.

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1 Introduction

The Hippopotamus, *Hippopotamus amphibious,* is a very well known species, which is recognisable and a great favourite with the general public, including children. Many zoos exhibit hippos and most people have seen one in the flesh. They have featured in human affairs since the time of the pharaohs and rock paintings and engravings can be found dating back 4000-5000 years (Eltringham, 1999).

Despite the popularity of the Hippo, little is known about its biology and what is known clashes with its jolly, roly-poly public image. Because of its aquatic and nocturnal habits, the hippo can be a difficult animal to study (Eltringham, 1999).

Hippopotamuses are distinct in appearance, with a large barrel shaped body ranging in weight from 1500 – 3000 kg. They have short, stout legs, large canine tusks and their mouth is capable of opening 150̊ (Eltringham, 1999). Hippos are generally found mud wallowing or submerged during the day and then are active at night, grazing on land. They usually remain submerged for 5-6 minutes and cannot actually swim, instead prancing along the bottom of the river bed. The hippo has a deep vocalization, called a 'wheeze-honk' which is a typical sound in the African wetlands and waterbodies (Kingdon, 1979).

1.1 ASMP Category

Artiodactyl TAG: Population Management Program; Management Level 1a (ASMP, 2008).

1.2 IUCN Category

VU; vulnerable.

1.3 EA Category

Not applicable.

1.4 NZ and PNG Categories and Legislation

Not applicable.

1.5 Wild Population Management

Not applicable.

1.6 Species Coordinator

ARAZPA Species Co-ordinator; Suzy Barlow, ARAZPA.

1.7 Studbook Holder

Davin Kroeger, Victoria's Open Range Zoo.

2 Taxonomy

2.1 Nomenclature

Class: Mammalia
Order: Artiodactyla
Family: Hippopotamidae
Genus: Hippopotamus
Species: *Hippopotamus amphibius*

2.2 Subspecies

There is substantial regional variation in this species which has led to a series of separate populations. These are not necessarily recognised subspecies, however are given for the sake of completeness.

H. a. amphibious	The nominate race is said to have occurred in Egypt where it is now extinct, and as far south as Tanzania and Mozambique.
H. a. tschadensis	This race is found in west Africa including Chad.
H. a. kiboko	Kiboko is Swahili for hippo. This subspecies is from Kenya and Somalia.
H. a. constrictus	The range of this race is Angola, southern Zaire and Namibia.
H. a. capensis	This is the southern African hippo (Elringham, 1999).

2.3 Recent Synonyms

None.

2.4 Other Common Names

Also known as the Common Hippopotamus (Estes, 1991) or large hippo (Eltringham, 1999).

3 Natural History

3.1 Morphometrics

3.1.1 Mass And Basic Body Measurements

Head-Body Length	280-350cm
Tail Length	35-40cm
Shoulder Height	130-165cm
Weight	510-2500kg (females), 650-3200kg (males) (Kingdon, 1979)

3.1.2 Sexual Dimorphism

The sexes are different in proportions with males generally being larger. They also have much larger canines and incisor teeth set into a massive skull and jaw which can open up to 150˚. Due to this, males have a correspondingly larger jowl and greatly thickened neck compared to females (Kingdon, 1979).

3.1.3 Distinguishing Features

Anatomy

The body shape of the Hippo reflects its amphibious lifestyle. They have a barrel shaped body with stumpy legs and splayed toes which are able to just carry their large bodies on land and fold out of the way when resting or swimming (Eltringham, 1999). The head shape is adapted to being immersed in the water; ears, eyes and nostrils are all along the top of the head and are opened and closed by small muscles. They have wide, flat lips which enable them to graze effectively and large jowls which house well developed muscles that aid in the opening and closing of their massive jaws to an angle of up to 150˚ (Kingdon, 1979). They have a short, vertically flattened tail which is flicked back and forth at a rapid rate to shower dung. Hippos are virtually hairless and have no sebaceous glands. They do however have unique glands which secrete a viscous red fluid thought to aid in preventing desiccation and possibly have healing properties. The main colour of the skin is purplish grey to blue-black. The underside, eye rims, ears and mouth show very variable expanses of pink (Kingdon, 1979).

Teeth

Hippo teeth are used for two very different functions. The front teeth consist of four massive, tusk-like canines and eight shorter, peg like incisors, four in each jaw. Both types grow continuously and serve no purpose in eating, being used solely for fighting. The canines project for about 30cm from the jaw and can have a root of up to 40cm within the gum. Such large teeth have a considerable trophy value and are used for carvings, often in replacement of elephant ivory. The molar or back teeth are used for feeding. There are six in each side of the top and bottom jaw, three premolars and three molars (Eltringham, 1999).

3.2 Distribution and Habitat

Hippos are confined to Africa, historically found anywhere throughout sub-Saharan Africa wherever conditions were suitable, that is, where there is water and open grazing. Their upper altitude limit is approximately 2000m. The present distribution of Hippos is shrinking (see Figure 3.1). A hHippo will aggregate in permanent water sources or wallows during the dry season and disperse widely during the rain season (Eltringham, 1999).

Hippos are influenced in habitat choice by the nature of the foreshore or the bed of lakes and rivers, as well as by the depth and flow of the water. Most groups of Hippos are found where there are relatively firm and gently sloping beaches and quiet waters where the Hippo can stand and kneel on the bottom and be close to the surface of the water for breathing and so young can be suckled easily (Eltringham, 1999).

Figure 3.1 Current distribution of *Hippopotamus amphibius* in Africa.

3.3 Conservation Status

An assessment of Hippo populations in Africa in 1996 found their numbers to be widespread and secure. However, since then there have been a number of changes in several of the key countries where Hippos are found (IUCN, 2008). The most recent estimates suggest there has been a reduction of 7-20% in the last 10 years and that the

reductions will have exceeded 30% over the next three generations (30 years). Although the causes of population decline are known (poaching and habitat loss), the threats have not ceased, nor is there any evidence to show that they will in the near future (IUCN, 2008).

CITES	Appendix II
IUCN Red List	Vulnerable A4cd

3.4 Longevity

3.4.1 In the Wild

Hippos live for approximately 40 years in the wild.

3.4.2 In Captivity

Hippos can live well into their 50's in a captive situation.

3.4.3 Techniques Used to Determine Age in Adults

To determine the age of adults, an examination of the teeth would be needed. This could be done with animals that have been conditioned to open their mouths for inspection, otherwise would require anesthesia. As with most mammals, the molar teeth erode through use at a rate that can be used to estimate the relative age of the animal, the older the animal, the more worn down its teeth will be. The order in which the teeth erupt from the jaw is also correlated with age (Eltringham, 1999).

4 Housing Requirements

4.1 Exhibit/Enclosure Design

The size and strength of the Common Hippo necessitates a stout barrier or moat to separate animals from staff and visitors (Miller, 2003). Hippos require water areas for submersing and pools should be at least 1.5 – 2.5 metres deep (Miller, 2003). There should be land areas as well to provide grazing opportunities and areas to bask, particularly in winter. For breeding groups, space should be available to separately house females with calves or separate the bull to prevent calf trauma (Miller, 2003).

4.2 Holding Area Design

Exhibited animals are sometimes required to be held off the exhibit for cleaning or maintenance, therefore adequate holding facilities for dangerous animals such as the Hippo, are required by the Exhibited Animals Protection Act (1995). Holding areas for Hippopotamuses are two phased and include a concrete yard and water yard as shown in Figure 4.1. The concrete yard requires shelter on three sides as well as a roof over part of this yard. In this area there should be a sprinkler system (Figure 4.2), ideally in the roof, to keep animals wet if they are required to be locked out of the water. Each concrete yard should have an attached water yard for the Hippo to submerse in. By having these two parts of the holding yard separated, the Hippo can be locked into either yard as required for cleaning, maintenance, social or veterinary requirements.

Figure 4.1 Photo of holding yard showing separate concrete and water yard. Taken 2 November, 2008.

Figure 4.2 Photo showing sprinkler system in nightyards. Taken 2 November, 2008.

4.3 Spatial Requirements

The General Standards for Exhibiting Animals (amended 2004) states that the size and shape of an exhibit must provide for the animal freedom of movement, both vertically and horizontally. It further states than an enclosure must be of sufficient size and the animals managed accordingly, as to:

a) Avoid undue domination by an individual or individuals; and

b) Avoid the risk of persistent and unresolved conflict between the group or individuals; and

c) Make it possible for an animal to withdraw from other animals or the public; and

d) Ensure that the carrying capacity of the enclosure is not exceeded; and

e) Prevent an uncontrolled accumulation of pathogens and parasites; and

f) Encourage and permit exercise and behavioural enrichment.

With regard to Hippopotamuses, it is particularly important to manage group size and not exceed carrying capacity, with particular respect to the water body. As they spend most of their time in water, and are generally only territorial when in the water (Eltringham, 1999) then it is important to manage the number of Hippopotamuses in each water body. If the carrying capacity is exceeded, then this will result in fighting which can lead to serious injury or even death.

4.4 Position of Enclosures

The position of the exhibit and holding yards is not required to face any particular aspect as the Hippos will move around and bask in different areas at different times of the year.

4.5 Weather Protection

As Hippopotamuses generally retreat to the water for protection from the weather, there is no specific requirement for this. However, nightyards should have protection on three sides and partially over the roof to offer protection from wind and sun whilst sleeping (Figure 4.3). Hippos will generally rest in the water during summer months, however, shade should still be provided either in the form of trees or an artificial roof to provide a shaded area for sleeping if required.

Figure 4.3 Photo showing protection from weather in nightyards. Taken 2 November, 2008.

4.6 Temperature Requirements

Heating is not required for Hippopotamuses as they will move between the land and water as they require, helping them thermo-regulate (Eltringham, 1999). The only requirement they have is to have water available for submersing as they have no control over water loss from their bodies through the skin (Eltringham, 1999).

4.7 Substrate

Recommendations show that natural substrate should be provided wherever possible to imitate natural conditions and that they should be non-abrasive to the animal's feet (EAPA, amended 2004). The Hippopotamus spends its daylight hours either in water or resting on sandy river banks (Kingdon, 1997). As such, Hippopotamuses should have sand areas for sleeping and resting during the day as shown in Figure 4.4. Ideally they should also have an area with mud for wallowing, separate to the water body they require.

During the night, Hippopotamuses move away from the water to spend the night grazing (Kingdon, 1997). For this reason, a large grassed area should be provided for the animals to graze in. The substrate most appropriate for nightyards is cement as this can easily be hosed for cleaning as required by the General Standards for Exhibiting Animals (EAPA, amended 2004).

Figure 4.4 Photo showing resting areas for hippos, both sandy substrate and shady areas on the island. Taken 2 November, 2008.

Figure 4.5 Photo showing lake area, island and grassed exhibit in the left background. Taken 2 November, 2008.

4.8 Nestboxes and/or Bedding Material

The Hippopotamus does not require any extra material for nestboxes or bedding as in their natural habitat they would be sleeping on sandy beaches or in shallow water (Kingdon, 1997). Therefore, adequate sand areas should be provided for all the animals to lie down and sleep.

4.9 Enclosure Furnishings

The General Guidelines for Exhibiting Animals (EAPA, amended 2004) states that an enclosure must include naturalistic furniture and, where appropriate, such items as bedding material, branch work, burrows, nesting boxes and pools to aid and encourage natural behaviour. Hippopotamuses require a constant water body for submersing as they are unable to control the loss of water from the body through the skin surface (Eltringham, 1999). It is therefore vital that deep pools are provided both in the exhibit (Figure 4.5) and nightyard. This is not only a basic requirement for them but also allows them to display natural behaviours such as grazing, sun baking, swimming and porpoising. Another natural behaviour for Hippopotamuses is wallowing and therefore an area of mud or clay should be provided for this. Particularly for breeding animals, large logs should be placed in the exhibit, on land as well as in shallow water, to provide a visual barrier. This also allows for a physical barrier for cows to hide their calves in after birth, which is a natural process for these animals (Eltringham, 1999).

5 General Husbandry

5.1 Hygiene and Cleaning

The Exhibited Animals Protection Act (EAPA) (amended 2004) states specific requirements for the cleaning and hygiene of exhibited animals. This includes the daily removal of excrement and waste, uneaten food, unwholesome food and water, bones, fur, feathers, dead animals and introduced waste and foreign objects. The daily removal of these is required to avoid the unsightly and unhealthy accumulation of these matters and to reduce vermin infestation and disease hazards, to reduce bad odours and prevent the ingestion of potentially harmful objects. Contaminated substrate must also be removed as necessary and care must be taken whenever using disinfectants. This must only be done under veterinary direction (EAPA, amended 2004).

Naturally, males will drop their dung on particular landmarks along their pathways and this creates large middens on the chosen boulder, termitary, stump, root or bush (Kingdon, 1979). The male Hippopotamus will spray their faeces over fences, walls and even the roof when defecating and so care needs to be taken to hose all these surfaces (*Pers obs*., 2007). Hippopotamus holding or nightyards must have the concrete surfaces cleaned every day by removing all faeces and uneaten food and then hosing the walls, fences and floor. Concrete surfaces can be scrubbed with light chemical agent such as F10 on an as needed basis, usually once a year for a thorough clean. Care should be taken to not use any stronger cleaning products such as bleach as the concrete yards slope down into the water where the Hippopotamus live. Apart from the defecation of dominant males on land, practically all defecation takes place in the water (Kingdon, 1979). This is also observed in captivity and there is usually only very little faeces to remove from the female yards and exhibits. Particular care should be taken to clean resting areas such as sandy banks where Hippopotamuses bask as they will defecate where they lie. These sandy areas should be raked and faeces removed daily. Then the sand should be replaced on a regular basis, approximately 3 times a year.

In the nightyard facility, there is a drain that runs along the bottom of the concrete yards to collect urine and faeces and direct them towards a sump at the end of the yards. This is to decrease the waste that runs into the water yards. As the concrete/rubber floors in the nightyards are hosed clean every other day, or daily for the male's yards, there is a buildup of leaves, old hay or faecal materials that collect in these drain sumps. On a regular basis, at least monthly but ideally every fortnight, these sumps are cleaned out. This involves digging out the waste that has settled to the bottom of the sump. This prevents drains from blocking. It is important that this job is done on a regular basis to prevent a lot of build-up which can then become an Occupational Health and Safety issue due to increased heavy lifting.

Between the two nightyard areas, there is a grassed area that requires whipper snipping once a month to prevent trip hazards being covered up and discourage snakes. The grass on the island in the large Hippo pond requires whipper snipping on a quarterly basis. The Hippos have to be locked into the nightyard facility to allow maintenance staff to row

over with their equipment and cut the grass. If the Hippos have had access to the island then there will be less need for the grass to be cut due to them grazing. Feed sheds should be raked daily to remove spilt hay and then cleaned more thoroughly on a monthly basis. Rat bait stations should be checked fortnightly and re-filled as needed.

It is important that gates and padlocks are in working order so that they can be moved easily and quickly. This is so that they can be opened quickly if Hippos need to be moved in a hurry. It is also an Occupational Health and Safety requirement as the gates required for the secure housing of Hippos are large and heavy and so need to be in good working order. Padlocks should be lubricated with Lanolin spray every two months. Then on the alternate months the rollers on the gates should be greased.

If the water body where the Hippopotamuses are exhibited is a natural water body such as a lake or dam then a large scale cleaning out may be required every couple of years (see Appendix 1 Annual Cleaning maintenance schedule). This will generally involve the emptying of the water and dredging the bottom of the water body (*Pers comm.*, 2006). If the water body is man made then it could be emptied more regularly and be cleaned with a high-pressure water cleaner.

5.2 Record Keeping

Each animal has an Animal Record Keeping System (ARKS) number and is recorded in the ARKS database. General information about the animal's identification number, name, microchip number, parentage, date of birth and acquisition/disposal and distinctive markings should all be recorded and kept in an easily accessed area. It is important to keep detailed daily records that are regularly updated.

The following details should be recorded:

Health	General condition of individuals, results of examinations or checks by veterinarians, medical observations, treatments.
Behaviour	Breeding and reproductive behaviours, problems, observations of interactions between individuals.
Diet	Changes in diet, observations of changes in appetite.
Measurements	Records of weights or measurements taken.
Movements	Movements within and between institutions.
Conditioning	Training or conditioning sessions and their outcomes and progress.

5.3 Methods of Identification

Microchip — Each animal needs to be identified permanently using a microchip, generally inserted into the intrascapular area.

Animals are able to be identified using face and body markings. Hippos have a variety of pink colourations on the face, neck and sometimes feet. They generally also have scars or scratches along their bodies which also help with identification. Each animal will also have a unique shape of tusks which can also be used to distinguish between individuals.

5.4 Routine Data Collection

Facilities holding breeding groups of Hippos need to take detailed weights of calves as they grow to graph growth and development.

6 Feeding Requirements

6.1 Diet in the Wild

Hippopotamuses are herbivorous foregut fermenters, with the vast majority of the food eaten being grass, although some broad leaved plants are bound to be ingested incidentally as well (Eltringham, 1999). They have been termed 'pseudo-ruminants' because, despite having a four chambered stomach, they do not ruminate. There is no caecum. Hippopotamuses crop grass entirely by the use of their wide, strong lips, not with the front teeth which play no part in feeding. They walk slowly, swinging their head in a regular pattern from side to side with the muzzle close to the ground. As the muzzle swings close to the ground, the lips close over a mouthful of grass and it is wrenched away (Kingdon, 1979). The grass is then passed to the back of the mouth by the tongue and chewed by the back teeth. Coarse, tussock forming grasses are not suitable as they slip through the lips and so creeping species are preferred (Eltringham, 1999). This grazing habit results in very short grass areas called "hippo lawns" which are then interspersed with areas of long grass. When Hippo density rises above a certain level, the longer grasses are exploited too and this can eventually lead to soil erosion (Eltringham, 1999).

Hippopotamuses will also sometimes eat aquatic plants, with observations being made of them nibbling on floating plants as well as various types of reeds (Eltringham, 1999) (Pers. obs, 2007). They will also occasionally eat the leaves, bark or fallen fruit of trees (Kingdon, 1979).

There have been many occurrences of Hippos being observed eating meat and even indulging in cannibalism. Observations of scavenging are most common, with them often being seen consuming the meat of other animals that have been killed, particularly by crocodiles. The killing of other animals has often been witnessed and is not surprising considering the highly aggressive nature of Hippos (Eltringham, 1999). Hippos that have been injured during fights are especially likely to vent their aggression on another species. Reports of predation have been commonly made, however it is assumed that it is more likely a case of aggression as predation implies killing an animal with the intention of eating it (Eltringham, 1999). Meat eating in Hippos should be regarded as either abnormal behaviour or more likely as a reaction to nutritional stress and the need to replace something missing from their natural diet (Eltringham, 1999).

Hippos are a nocturnal species and move out of the water during the night to feed. They can move anywhere between 5-10km away from water and spend up to 5 hours grazing during the night (Kingdon, 1979).

6.2 Captive Diet

As a non-selective grazing species, captive Hippos are commonly fed a high fibre ration based on grass hays. They typically consume approximately 1.5% of their body weight daily (dry matter basis). Hippo diets should contain approximately 12-15 % protein and

38-44% neutral detergent fibre. Due to their largely sedentary lifestyle and restricted movements where they would naturally walk anywhere up to 10km in a night to graze, care needs to be taken to avoid animals becoming overweight. Hippos can sometimes tend towards obesity which can lead to problems with breeding and cause arthritis in later life. For this reason, care should be taken to avoid Lucerne hay. The Hippos at Taronga Western Plains Zoo are fed on meadow hay only.

It is important to know the weight of a Hippopotamus so as to determine the amount of hay to be fed out. The following is an example of a Hippo feed chart, taken from Taronga Western Plains Zoo.

Table 6.1 Feeding chart for the Hippopotamus from Taronga Western Plains Zoo.

Animal	Daily Requirements
Happy	Offer 16 kg meadow hay (and 1 kg meadow hay left on the boat (at beach) for Zoofari at night). Does not have access to grass for grazing. Happy should be fed in the box daily. Some of his food can be fed out on the beach side of AFX11 as he can take too long in the box. He should be fed in the box first, before feeding on the exhibit. Happy MUST NOT have access to the raceway overnight.
Mana	Offer 17 kg meadow hay. Feed Mana only in the box from AFN66. Mana can be fed once during the day and again at 4pm when the girls come in.
Rumbin	Offer 6.5 kg meadow hay. She has access to grass for grazing. Still requires more weight loss. Rumbin can be fed in the cement holding yard AFN 59. Don't let her out until Mafuta has finished her ration.
Mafuta	Offer 8 kg meadow hay. She has access to grass for grazing. Still require more weight loss. Mafuta can be fed in the cement holding yard AFN 60. Don't feed her out on exhibit as she becomes reluctant to come into the holding yards. If Mafuta doesn't come in, hold her food back and offer her 12 kg meadow hay the next day. Record on report if she doesn't come in, and extra food given.
Suzie	Offer 8 kg meadow hay each in PM. Does not have access to grass for grazing. Still require more weight loss. PM - Suzie being locked into AFN 64 or AFN65. Rotate between the two.
Nile	Offer 13 kg meadow hay in PM. Does not have access to grass for grazing. PM - Nile being locked into AFN 64 or AFN 65. Rotate between the two.

Hippo Beach	AM - Offer 2kg meadow hay each, placed in two (2) separate piles for public feed. This feed is added to be a part of their total daily ration.

Ideally, a large grassy area should be provided for Hippopotamuses to graze on, which provides food, exhibits natural behaviours and provides exercise (Figure 6.1).

Figure 6.1 Photo showing large grassed exhibit for Hippopotamus grazing. Taken 2 November 2008.

6.3 Supplements

Hippos generally do not require any dietary supplements. However, if there are any cracks or problems with their nails and feet, veterinary assistance can be sought to prescribe a Biotin supplement such as Hoof Food which can be given to encourage healthy nail growth. These supplements can be purchased from most equine product suppliers.

6.4 Presentation of Food

As Hippopotamuses generally spend a lot of time in the water, feeding is a great way to get them out of the water and in front of the public. Keeper talks are best given during a scheduled feed so the animals are clearly visible. Hay should be placed in an area where Hippos can easily eat and preferably can be cleaned easily, such as a concrete surface. If there is more that one individual at the feed, hay should be spread into several piles to avoid dominant animals consuming more (Figure 6.2).

Figure 6.2 Photos of Hippos feeding at a scheduled feed, showing many piles of hay to allow even feeding opportunities. Taken 7 December, 2008.

As each animal is fed according to weight, it is ideal to separate Hippopotamuses for feeding, usually at night which is when they would naturally be feeding (Table 6.1).

Enrichment can be given in the form of fruit or vegetables such as apples, lettuce or pumpkin. A whole pumpkin is particularly good as it floats and so the hippos will swim around chasing them and then bite them open and have to find all the pieces. Pumpkin seems to be particularly appealing to them with regard to taste as well. These foods can also be used for training purposes; however, they will easily be conditioned with hay as well.

Figure 6.3 Photo showing hippo enjoying pumpkin enrichment feed. Taken February 2007).

7 Handling and Transport

7.1 Timing of Capture and Handling

The capture of Hippopotamuses should be a well planned and executed event, which normally takes months of conditioning animals to transport containers or a crush. The timing for the capture of the Hippos depends on the particulars of the transport. If the transport is short, such as an internal movement within the zoo, then an early morning capture would be best to give the Hippo daylight hours to familiarise with the new facility whilst still being in the cooler part of the day to avoid heat stress. However, if the transfer is over a great distance, it would be best to capture the Hippo in the evening and transfer them overnight when it is coolest.

7.2 Capture and Restraint Techniques

A crush is the best way to physically restrain a Hippopotamus. Training and conditioning can be done to be able to calmly restrain them in a chute or transport crate. Hippos that are not conditioned in this way will need to be chemically restrained. Chemical restraint in Hippos requires veterinary assistance to anaesthetise, usually with Etorphine, and is particularly risky due to their size and the fact that it is particularly difficulty to manage the level of anaesthesia in Hippos. This is discussed in chapter 8.2.1.

To capture a Hippopotamus for transport, it is best to condition the animal to move into a transport crate and be comfortable being closed into this crate. It is impossible to physically manipulate an untrained animal into a crate due to their size and aggressive nature.

Figure 7.1 Photo of hippo being conditioned to crush. Taken August 2006.

7.3 Weighing and Examination

The weighing of Hippos requires large animal or industrial size scales. Animals can be conditioned to stand on scales that may be placed in a raceway or crush. Alternatively, they could be placed under a transport crate that animals are conditioned to enter.

Simple health checks and procedures can also be done in the crush with Hippos that have been conditioned to this. Such procedures may include inspections of the mouth and tusks, filing of the tusks and ultrasound. More involved procedures and procedures on Hippos that are not conditioned to come into a crush will require chemical restraint as discussed in 7.2.

Figure 7.2 Photo showing transport crate placed in raceway for conditioning. Note the blue cords for the scales underneath the crate. Taken 2 November 2008.

7.4 Release

Release from the crush is as simple as opening a slide and letting the Hippo go. However, release from a transport crate, particularly after a long transport is more difficult. As the Hippo is probably slightly stressed from the process, care needs to be taken when releasing them from the crate as they will most likely charge out. The release area should preferably be in an open space that is free from objects that a charging animal could collide with such as trees, troughs or discrete fences. The transport crate should be facing a water body for the hippo to submerge in as this is where they feel most comfortable and protected and will generally head for water as a preference.

7.5 Transport Requirements

The International Air Transport Authority (IATA) is responsible for setting the standards of live animal transport on any member airline. The IATA Live Animal Regulations have General Container Requirements for Non-Domesticated Mammals as well as specific container requirements for Hippopotamuses. The general requirements cover design and construction, dimensions, stocking density, ventilation, feeding, watering and labeling. They also cover special care seeing as most non-domesticated animals are disturbed by handling, movement, light and noise which can cause stress to the animal and be bad for its general health. IATA states that stress should be minimized by reducing the light within the container, noise level and moving the container as level and little as possible. This can be done by holding animals in a darkened area with as little noise as possible and only moved out to the aircraft shortly before departure (IATA, 2005).

The container must be correctly labeled and marked with the consignee's name, address and telephone number. Labels must not block ventilation openings (IATA, 2005). The container must be easy for staff to handle and provide the handlers with protection from injury from the hippo. The container must not cause the animal to hurt itself and must be constructed so that accidental opening cannot occur (IATA, 2005).

7.5.1 Box Design

The size and strength of the container must be sufficient to restrict the movement of the Hippo as well as restrain it. The Hippo needs to be able to stand naturally without being cramped but must not be able to move freely. The frame must be made of strong, metal welded or bolted together depending on the weight of the animal. The sides must be made of solid hardwood, with no internal projections and line the outer framework. The lower part of the sides must be solid and leak proof. The floor must be tongue and groove of 2.5cm, have a non-slip surface and be completely leak proof. The roof needs to be solid over the animals head and shoulders and slatted over the loins for ventilation. A series of metal bars must be bolted to the top and bottom of both the entry and exit of the container. Exterior to this, there must be sliding or hinged doors that completely cover the entry and exit and that have ventilation openings over the upper third part (Figure 7.3). There must be forklift extrusions as an integral part of the design.

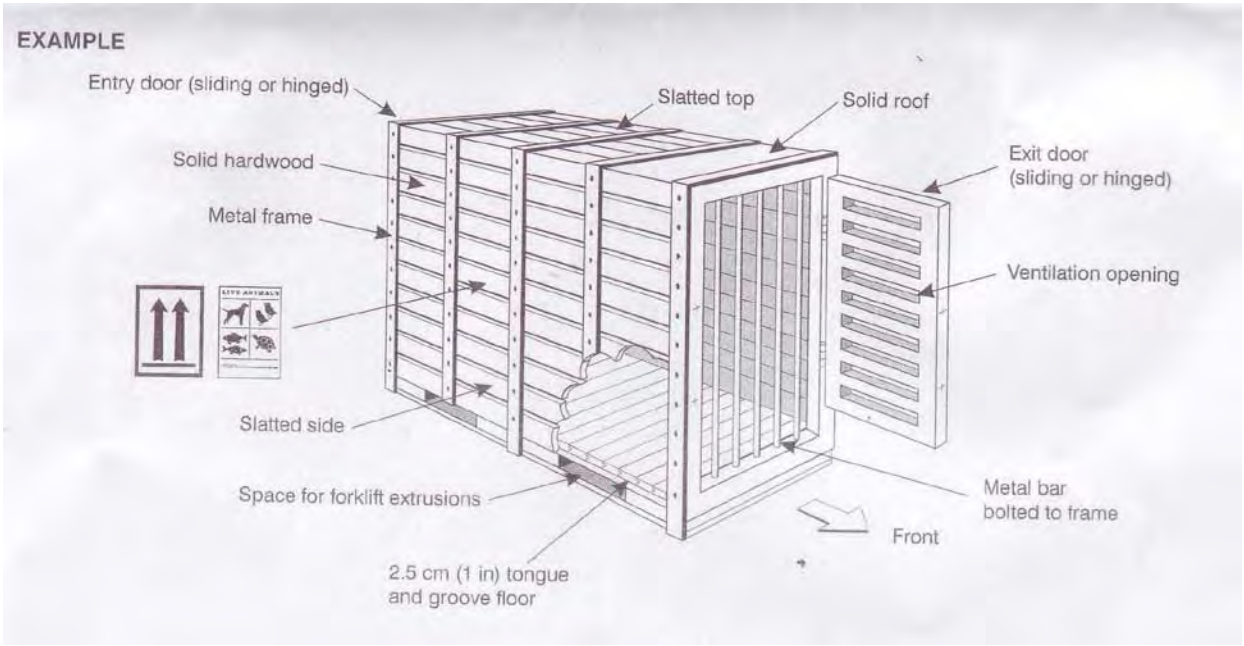

Figure 7.3 Dimensions of transport crate for hippopotamus.

7.5.2 Furnishings

Absorbent bedding must be provided by the shipper that is suitable for the species, such as wood shavings. Straw is unacceptable as many countries prohibit its importation (IATA, 2005).

7.5.3 Water and Food

The water container must be fixed in the front of the container, made of strong metal with rounded edges and must be wide enough to fit the Hippos muzzle. Outside access is from a low wooden flap, clearly marked FEEDING. Food can be placed between the bars and the door; the access flap must be securely closed when not in use. The Hippo must be watered before shipment and will generally not require feed or water during 24 hours after dispatch. If feeding or watering is required due to unforeseen delay, instructions must be supplied by the shipper (IATA, 2005).

7.5.4 Animals per Box

Hippos must be transported in an individual container (IATA, 2005).

7.5.5 Timing of Transportation

For Hippos being transported long distances, late afternoon capture for an overnight transport is ideal to reduce heat stress.

7.5.6 Release from Box

This is discussed in 7.4.

8 Health Requirements

8.1 Daily Health Checks

Initial examinations performed in the morning will usually consist of a simple head count as animals are usually in the water. A more detailed examination can be performed after cleaning and feeding when the Hippopotamuses are up on land and in close proximity. Some basic observations include the following:

- Examination of body including weight/condition, skin is not dry and cracked, check for any wounds or injuries.
- Ensure that the Hippopotamus has a normal gait and that no limbs are afflicted with injuries and are moving freely.
- Check that appetite is normal; a lack of enthusiasm to eat in a Hippopotamus is a good indicator of ill health.
- Eyes are clear and open.
- Faeces are of a normal consistency.
- Changes in behaviour are noted.
- Mouth is observed open and all tusks checked for breakage.

8.2 Detailed Physical Examination

8.2.1 Chemical Restraint

Sedation or immobilization of Hippos has historically resulted in relatively high mortality (Miller, 2003). Factors that contributed to the high mortality rate include;

- A Hippos nostrils are set on top of the muzzle and are able to close,
- The skin contains abundant mucous glands that secrete an oily substance that can make handling difficult,
- When Hippos feel threatened they will retreat to the water,
- Thick skin confounds attempts to obtain diagnostic samples and monitor anesthesia, and
- Historically large doses of Etorphine were used for immobilization (Miller, 2007).

The ability to train animals to enter restraint devices, obtain accurate weights on Hippos, along with improvements in drug delivery systems, and availability of newer more potent, and reversible anesthetic agents have increased the number and success of Hippo anesthetic procedures in recent years (Miller, 2007).

Careful planning and preparation are important aspects of any immobilization but particularly with the Hippopotamus. Preparations include securing an area where the Hippo will be contained and prevented from entering the water either prior to or after initial darting. There should be moving equipment such as a forklift on standby in the event of the animal falling in a compromised position (Miller, 2007). Procedures should

be planned for the coolest part of the day and the Hippo should be fasted for at least 48 hours and water intake restricted for at least 24 hours before the procedure. This fasting is useful in decreasing the weight of the gut contents on the diaphragm when the Hippo is recumbent (Miller, 2003).

The most common site for drug injection is in the neck just behind the ear, but can also be in the caudomedial thigh. Induction time may vary depending on the type of drug used and the depth of subcutaneous injection (Miller, 2007). Depending on the drug used, initial signs vary but Hippos may show ataxia (loss of muscle co-ordination), vocalize, and have increased sweating and salivation. They often "dog sit" prior to becoming recumbent (Miller, 2007). Several anesthetic drug regimens have been used to chemically restrain Hippos. Traditionally Etorphine was used, however, other combinations were evaluated due to the high level of fatal complications and difficultly with acquiring Etorphine. Reversible and/or short acting drug for induction (Medetomidine or Detomidine with or without Ketamine) with maintenance by inhalant anesthetics (Isoflurane) have given the most satisfactory results (Miller, 2003).

Once immobilized, it is important to have water available to help keep the Hippo's skin moist and aid in thermoregulation. Along with temperature, monitoring of respiratory rate, heart rate, and oxygen saturation are critical to a successful anesthetic outcome (Miller, 2003). Intubation and administration of oxygen in recommended for any surgical or other prolonged medical procedures (Miller, 2007). Complications with apnea, bradycardia, and hypotension can occur and the veterinarian should be prepared to administer supplemental oxygen and Doxapram as needed. If adverse signs are significant, consideration should be given for complete reversal (Miller, 2007). Once the procedure is completed, the Hippo should ideally be placed to reduce the risk of injury upon reversal of anesthesia. Reversal agents should not be administered until all equipment and staff has been moved to a safe area (Miller, 2007). Once the animal is alert and walking steadily, it can be provided with hay and drinking water; however the Hippo should not be given access to a pool for at least 24 hours to prevent drowning in the case of re-narcotization. A mister or sprinkler system should be used to keep the Hippo comfortable (Miller, 2007).

8.2.2 Physical Examination

Diagnostic techniques can be impeded by the difficulty in accessing the animal to obtain samples. Limited examination may be made possible with conditioning and mechanical restraint devices. Procedures that can be performed include thorough oral examination, ophthalmic evaluation and visual and limited tactile evaluation of skin and superficial structures such as palpation of the surface of joints, toenails and feet (Miller, 2003). Captive Hippos should undergo an annual detailed examination.

Key observations to gauge the health of Hippos are:

Skin condition	Poor skin condition such as cracks and peeling skin can be due to animals not having adequate access to the water or an indication of poor health.
Mouth inspection	Hippos can be prone to damaging their tusks during fights, in particular males. The tusks and mouth should be inspected to ensure that no tusks are broken or if they are that the nerve hasn't been exposed.
Signs of trauma	Any signs of fighting amongst Hippos will usually be in the form of wounds from tusks along the skin surface. These wounds can be significant and may need antibiotics to help stop massive infection.
Feet	As hippos have soft pads on the bottom of their feet these can be prone to injury, particularly if they have spent some time out of the water. The nails can sometimes have issues with cracking as well.
Gait	Hippos should be observed walking on land every day if possible to assess their gait and any problems that may occur with their legs or hips. Particularly as they get older, Hippos can be prone to arthritis.

Some key diagnostic tests for Hippos are:

Blood	The thick skin of hippos makes most vessels difficult to visualize. A common site for venipuncture is the tail.
Faeces	Samples of faeces can be obtained even though most defecation occurs under water. These are particularly useful in checking for parasites.
Urine	Can be collected by catching it in a cup attached to a pole. Urine stream is usually projected backwards, although may sometimes be contaminated by faecal material.
Hematology	Due to the difficulty in obtaining blood, only limited analysis have been performed. Because many of the samples that have been collected are from sick or dying animals, 'normal' hematological parameters have not been well defined.

8.3 Routine Treatments

- Faecal screening for parasites is performed twice yearly and worming medications are dispensed according to the results of those tests (personal observation).
- At the present time, vaccinations are generally not recommended (Miller, 2003).
- Conditioning for routine tusk trimming can prevent oral traumas in those animals with long, malformed or broken tusks (Miller, 2003).

8.4 Known Health Problems

Obesity

Cause	Obesity or overnutrition is a common problem in captive Hippos, which may in turn exacerbate other problems such as degenerative joint disease or osteoarthritis (Miller, 2003) and lead to problems with breeding (TWPZ Hippo Diet Sheet, 2009). Due to their largely sedentary lifestyle and restricted movements in captivity, where they would naturally walk anywhere up to 10km in a night to graze, care needs to be taken to avoid animals becoming overweight.
Sign	Obesity is best gauged by body condition, the amount of fat rolls and the size of the belly. Hippos naturally have jowls around the neck and small folds of skin around the legs (Kingdon, 1979) but they should not be pronounced into rolls and the belly should be flat between the front and back legs. Weight measurements can be taken to get accurate indications of whether the animal is obese.
Treatment	Obese Hippos will need to be put on a strict diet. Their intake should be slowly reduced to a level that will cause them to lose weight at a steady and gradual rate.
Prevention	Hippo diets should be very carefully monitored. All hay should be weighed and adjusted accordingly to their weight loss or maintenance needs. Male Hippos will continue to gain in size throughout their life and female Hippos will plateau at around the mid thirties and this should be taken into account for their diets. Hippos should be weighed on a regular basis to keep a record of their weight. As a non-selective grazing species, captive Hippos are commonly fed a high fibre ration based on grass hays. They typically consume approximately 1.5% of their body weight daily (dry matter basis). Hippo diets should contain approximately 12-15 % protein and 38-44% neutral detergent fibre. As Hippos can sometimes tend towards obesity care should be taken to avoid Lucerne hay. The Hippos at Taronga Western Plains Zoo are fed on meadow hay only (TWPZ Hippo Diet Sheet, 2009).

Dental Problems

Cause	Dental problems are common in captive Hippos (Miller, 2003) and are usually caused through fighting with other Hippos or attempting to fight between steel fences.
Sign	Broken or abnormal tusks may result in oral trauma, with the formation of penetrating wounds and fistulas (Miller, 2003).
Treatment	Wounds will usually be treated with antibiotics and/or anti-inflammatory drugs administered either by dart or oral medication. Dental surgery may need to be performed in extreme cases where tusks have broken below the gum line and exposed the pulp of the tooth, or damage is occurring due to overgrown tusks.
Prevention	Is best done through the trimming of tusks which can be successfully performed using restraint devices and husbandry training. Gigli wire, handsaws and power tools have been used to trim or dull the tips (Miller, 2003).

Figure 8.1 Photo showing dental problem due to overgrowth. Being fixed by sawing through tusks with Gigli wire to remove sharp egde.
Taken August 2009 at TWPZ.

Musculoskeletal

Cause	Inactivity, limited exercise space, obesity, and housing on hard surfaces (concrete) for long periods of time may contribute to the development and progression of musculoskeletal problems (Miller, 2003).

Sign	Chronic lameness associated with degenerative joint disease, osteoarthritis and soft tissue trauma are relatively common clinical signs, especially in older captive Hippos (Miller, 2003).
Treatment	Hippos have been treated with nonsteroidal anti-inflammatory drugs commonly used in domestic large animals (Miller, 2003).
Prevention	Appropriate substrate such as rubber flooring, large areas for exercise and encouraging Hippos to move around by spreading food in many areas, carefully monitoring diet to avoid obesity and large water areas for exercise.

Trauma

Cause	This is usually due to fighting between Hippos. Males and females will all exhibit aggression towards each other at various times. The most significant cause of neonatal mortality in captivity is trauma, including parental aggression (typically the male) (Miller, 2003).
Sign	Range from simple puncture wounds, abrasions, and lacerations to massive gaping punctures in limbs and tearing wounds along the torso.
Treatment	Small wounds usually heal without intervention. Wound treatments include flushes, topical applications of various antimicrobial ointments or powders and antibiotics.
Prevention	Captive populations should be managed carefully. Males should never be housed together, particularly when there are also females in the same facility. Care should be taken to avoid overcrowding Hippos as this will also cause friction. Behaviour should be monitored carefully to watch for any signs of aggression between Hippos kept in the same exhibit so adjustments can be made to avoid large scale fights.

Fluke Infection

Cause	Infection by the fluke worm *Oculotrema hippopotami*, usually located in the conjuctival sac (Miller, 2003).
Sign	Signs of tearing, blinking, conjunctivitis (Miller, 2003).
Treatment	None.
Prevention	Usually seen in wild or recently imported Hippos (Miller, 2003).

Coccidia

Cause	Single celled, microscopic parasites that infect the intestinal tract.
Sign	Found on faecal flotation (Miller, 2003).
Treatment	Usually asympomatic but may be treated with anticoccidials (Miller, 2003).
Prevention	Avoid overcrowding and clean feed areas to avoid ingesting faecal

	material.

Nematodiasis

Cause	Worm infestation caused by *Ascaris sp. and Capillaria sp.* which are species of roundworm (Miller, 2003).
Sign	Found on faecal flotation (Miller, 2003).
Treatment	Antihelmintic medication (Miller, 2003).
Prevention	Regular faecal testing, avoid overcrowding and clean nightyards and feed areas.

Streptococcal infection

Cause	Infection of *Streptococcus spp.* a bacteria (Streptococcus, 2009).
Sign	Many varied signs such as lethargy, dermatitis/cellulitis, septicemia, vasculitis, abortion, placentitis, mastitis and osteomyelitis. Found through culture of the affected tissue (Miller, 2003)
Treatment	Systemic antibiotics and supportive care (Miller, 2003).
Prevention	None.

Salmonellosis

Cause	Infection of *Salmonella spp.* a bacteria (Salmonellosis, 2009).
Sign	May be asymptomatic. Signs include decreased appetite, lethargy, nasal discharge, enterocolitis. Confirmation through faecal culture (Miller, 2003).
Treatment	No treatment needed if asymptomatic, otherwise consider antibiotics based on the sensitivity of the bacteria cultured.
Prevention	Maintain hygiene, clean feed and water troughs, clean away any bird faeces.

Anthrax

Cause	Infection by the bacteria *Bacillus anthracis*. In herbivores such as the Hippo, it is contracted through grazing as the spores lie dormant in the soil for decades (Anthrax, 2009). Anthrax is the most significant infectious disease in wild Hippos (Miller, 2003).
Sign	Difficulty breathing and sudden death.
Treatment	Can be treated with antiobiotics if treated within the first two days of contraction but usually the first sign in animals is death.
Prevention	There is a vaccine against Anthrax but it must be given before exposure and requires many boosters.

8.5 Quarantine Requirements

In-house quarantine protocols formulated by Taronga Western Plains Zoo (TWPZ) veterinarians according to the relevant disease risk posed by the incoming species, applies to animals received from institutions within Australia (TCSA Quarantine Policy, 2008).

Animals received from overseas institutions will undergo a post-arrival quarantine protocol as prescribed by Australian Quarantine and Inspection Service (AQIS) according to the relevant Import Risk Analysis (IRA) (TCSA Quarantine Policy, 2008).

Hippos, being an Artiodactylid, must remain in quarantine until they are found to be free of Johnnes disease by negative faecal cultures on a pair of samples collected 7 days apart. The minimum period for the demonstration of a negative Johnnes result (for ovine strains of the pathogen) by this means is 12 weeks. Consequently the minimum quarantine period for incoming Artiodactylids will be 12 weeks (TCSA Quarantine Policy, 2008).

All Artiodactyls are to be held in quarantine until results of faecal culture for *Mycobacterium avium* subsp *paratuberculosis* (Tuberculosis) are available. Two individually identified faecal samples collected from each animal one week apart are to be submitted for culture. Three faecal samples are to be collected for faecal egg count (fec), with anthelmintic therapy as required (TCSA Quarantine Policy, 2008).

Each animal usually undergoes immobilisation for physical examination, unless the risk of anaesthesia is deemed too great as in the case of the common Hippopotamus, with blood collected for routine haematology, biochemistry and serum storage (TCSA Quarantine Policy, 2008).

Vaccination with a 5- in-1 clostridial vaccine should be undertaken where appropriate (TCSA Quarantine Policy, 2008).

An animal will only be released from quarantine when veterinary staff are satisfied that the quarantine risk is acceptable (TCSA Quarantine Policy, 2008).

9 Behaviour

9.1 Activity

Although capable of fast movement when alarmed or provoked, the Hippo has few conspicuously energetic activities (Kingdon, 1979). A Hippo will spend its daytime hours lying in the shallows or sleeping on a sandbank by the water (Estes, 1991). Tests show that Hippos are unable to control the rate of water loss through their skin and that their ability to deal with heat stress would be severely limited. It is thought that this may be the reason for the semi-aquatic lifestyle where temperature control is achieved by spending the day in the water (Eltringham, 1999).

Hippos are nocturnal and will spend the night out grazing. The grazing grounds can be some distance from the water and the Hippos may have to walk up to several kilometers to reach them (Eltringham, 1999). It seems that Hippos feed for relatively short periods at a time and rest in between, presumably to allow time for digestion. If some distance from water they may rest under a bush, however if close enough to home they will simply slip back into the water or wallow for a rest (Eltringham, 1999). Whatever forms their nocturnal activity may take, most Hippos are back in their wallows well before dawn (Eltringham, 1999).

9.2 Social Behaviour

9.2.1 Communication

Since hippos spend their days submerged and come ashore at night, auditory, olfactory and possibly tactile communication should be particularly important in this species (Estes, 1991). The resonant honking call made by submerged hippos is one of the most familiar and impressive African wildlife sounds (Estes, 1991). Hippos exhale their breath to express threat and alarm (Estes, 1991).

Dung and urine showering in the land and on water is clearly of central importance in Hippo social life (Estes, 1991). The Hippo's tail is a very efficient muck spreader and is wagged vigorously during defaecation so that the dung, which is loosely constituted, is widely scattered (Eltringham, 1999). In addition to normal olfactory reception, urine-testing with the vomeronasal organ, presumably functions to communicate the reproductive status of females and possible of males as well (Estes, 1991). Although Hippos do not make the flehmen grimace that other ungulates use to test urine, the vomeronasal organ appears to be designed to function under water, operating like a syringe bulb to draw in a sample of voided urine (Estes, 1991). This could explain the habit of females and subordinate males urinating when approached by bulls (Estes, 1991). Visual signals also play an obvious role in the daytime interactions of submerged Hippos such as yawning displays, charging and dung showering (See Appendix 2, Hippo Behaviour Ethogram).

9.2.2 Social Life

Social life for Hippos tends to be confined to the river or whatever body of water in which they spend the day (Eltringham, 1999). Hippos are highly gregarious, contact species in the water, but solitary when foraging (Estes, 1991). The Hippopotamus is socially schizophrenic, tolerating close contact in water or resting on shore and yet at other times being highly aggressive (Estes, 1991). Hippos are territorial only in the water, with the males holding a linear territory consisting of the shoreline and a narrow strip of the bank (Eltringham, 1999). Territorial bulls usually tolerate bachelor males within their domain and even in cow herds, so long as they refrain from sexual activity (Estes, 1991). The infrastructure of female herds is no known as well but appears to remain fairly consistent for several months at a time. The does however appear to be no close ties between cows apart from maternal bonds with daughters persisting at least to sub-adult age (Estes, 1991). The only other social grouping is bachelor herds of males (Eltringham, 1999).

Photo 9.1 Hippo defecating over subordinate animal.
http://tolweb.org/onlinecontributors/app?page=ViewImageData&service=external&sp=7546

9.2.3 Territoriality

The size of territories varies but is approximately 250 to 500m of lake shore or 50 to 150m of river and associated banks (Eltringham, 1999). Territorial males assert their status by adopting a proud stance with the head held high and ears cocked (Eltringham, 1999). Territorial bulls have frequent ritualized encounters where they approach each other at common boundaries, shower urine and dung over each other, shower water or each other with their mouths and then withdraw back to the water (Estes, 1991). If a bachelor male attempts to supplant the territory holder or the territorial male tries to

enlarge his territory, the consequences are much more violent (Eltringham, 1999). The pair will stand side by side, nose to tail, and deliver vicious swings of the head, gashing the opponent's flank with their huge canine teeth. Serious wounds may result and may puncture the peritoneum which will cause death (Eltringham, 1999). For the most part, wounds heal quickly and such serious fights are rare (Eltringham, 1999).

Females live in territories which they return each morning after the night's grazing (Eltringham, 1999). Female choice may be based on the male but is more likely to depend on topographical features such as the depth of water, lack of strong current and the presence of gently shelving banks on which to loaf (Eltringham, 1999). The females are in no sense territorial and are not necessarily confined to a single territory although most return to the same one. Territorial bulls have exclusive mating rights to the females living within his territory (Eltringham, 1999).

Photo 9.2. Picture of two male Hippos fighting.
http://www.photographersdirect.com/buyers/stockphoto.asp?imageid=241783

9.3 Reproductive Behaviour

Bulls questing for mating opportunities may wander through basking nursery herds sniffing at cows backsides, at the risk of being mobbed should the cows become disturbed (Estes, 1991). To avoid this, a bull moves very carefully and if a female stands up or there is an alarm, he lies down in submission, defecating over the densely packed herd (Kingdon, 1979). Having located an estrous female, the male will waste no time on courtship displays but will pursue her through the water until she turns and clashes jaws with him (Estes, 1991). The pushing contest that follows takes place in the shallows and the male's superior size and weight are decisive, and the female finally adopts the prostrate position which allows the male to mount (Kingdon, 1979). As she is generally submerged, she has to raise her head to breathe occasionally (see Figure 10.1) and even though he is copulating, the male snaps when she does this, thus reinforcing his dominance and her submission (Kingdon, 1979). The male's courtship is usually punctuated by wheeze-honking (Estes, 1991).

Cows isolate prior to calving, on land or in shallow water (Estes, 1991) and do not return to the herd for a couple of weeks (Eltringham, 1999). During this time she is fiercely defensive of the calf and can be dangerous to people (Eltringham, 1999). Baby Hippos are adapted for nursing underwater, even out of water their ears fold and their nostrils close while sucking (Estes, 1991). Every few seconds a submerged sucking calf pops to the surface, breathes, and goes back to the nipple, gripping it between the tongue and the roof of the mouth (Estes, 1991). The bond between mother and calf is close with the mother licking, nuzzling and scraping the calf with lower incisors and the calf reciprocating (Estes, 1991). Small calves may be left in a crèche guarded by one or a few Hippos while their mothers are away at pasture. Calves in crèches often engage in play fights and chasing games (Estes, 1991). It is thought that clustering in the water has evolved for the protection of calves against predators. Aggression or trampling by other Hippos, particularly bulls, is the greatest danger to calves (Estes, 1991).

9.4 Bathing

Hippos spend the day in the water digesting (Estes, 1991). They have also been known to occupy wallows during high rainfall periods (Kingdon, 1979).

9.5 Behavioural Problems

The Hippo may be aggressive toward people and is said to be the most dangerous of wild artiodactyls (Nowak, 1991). Females with young are especially aggressive and are prone to turning over or damaging boats and biting the occupants to death (Nowak, 1991). This aggressive nature can be carried over into the captive situation and they are therefore classified as dangerous. Although there is potential to tame them and make them easier to handle (Eltringham, 1999) they are socially schizophrenic and unpredictable in behaviour (Estes, 1991).

Photo 9.3 Picture of Hippo yawning – threat display.
http://www.wildlife-pictures-online.com/hippo-reputation.html

Zoos are not breeding Hippos to their full capacity and much below that which would occur in the wild (Eltringham, 1999). Calf mortality is too high and many deaths are caused by maternal neglect and injury from other Hippos (Eltringham, 1999). A potential problem is that a lot of Hippos are bred as monogamous pairs, which is unlike the natural

situation and the undivided attention of the male may be stressful to the female (Eltringham, 1999).

9.6 Signs of Stress

As mentioned in 9.5, an indicator of stress may be exhibited in the high rate of infant mortality of Hippos in captivity. Aggression towards exhibit mates may also be an indicator of stress, Hippos will usually only fight seriously over territories, or as the watering holes shrink at the end of summer (Kingdon, 1979). This may indicate that Hippos are housed in water territories that are too small or in less than optimum social groupings.

9.7 Behavioural Enrichment

Enrichment for Hippos can be based on food, environment or social interactions. Sand areas next to water provide good loafing positions and large logs provide areas on which males can base dung middens. There is an assumption in zoos that Hippos are mainly aquatic creatures and although a large pool is usually provided, less attention is given to the animal's terrestrial needs (Eltringham, 1999). Grazing areas are also of great importance for Hippos to exhibit natural behaviours during the night.

Social interaction is important for female Hippos and thus should be housed in groups. If this is not appropriate, then fence contact with other Hippos is beneficial.

Hippos enjoy different types of food enrichment such as fruits and vegetables and like nothing more than to chase a pumpkin floating in the water. Large barrels either floating free or attached to a point may be enjoyed as a jousting partner.

9.8 Introductions and Removals

Introductions with Hippos should be undertaken very carefully. Mating introductions are discussed in 10.10. As males are territorial, they should not be introduced with each other. When females are introduced they should have fence contact first to become familiarized with each other. Less dominant females should be introduced in a large area with the most dominant female introduced last. This gives the other females time to form bonds which will help stop sub-ordinate animals being ganged up on. Introductions should be done during the morning so behaviour can be observed during the course of the day and if unsure how things will progress overnight they can be separated for the course of the night.

9.9 Intraspecific Compatibility

As discussed in 9.8, introductions should be undertaken carefully. However as a herd animal, Hippos should be kept in multi-specimen groupings. Males should be kept

separate as territorial bulls would keep to themselves in the wild with the exception of looking for estrous females and matings.

9.10 Interspecific Compatibility

Frustrated Hippos, particularly younger males, have been known to vent their aggression on other species (Kingdon, 1979). A Hippo is also capable of killing a crocodile and will often displace them for basking sites and does not tolerate their presence within 2m of the herd (Eltringham, 1999). Hippos do have commensally beneficial associations with birds and often they will use the backs of hippos as fishing sites (Eltringham, 1999). Eltringham (1999) states that species of Stork, Spoonbill Egret and the Goliath Heron have been observed on a regular basis and species such as Egyptian Goose, Spurwing Goose, Whistling Duck and Little Grebe on a less regular basis, looking for plant material that Hippos displace. Any of these species, or other African species of birds would exhibit well with Hippos. Another possibility would be exhibiting arboreal primates which would be safe from the Hippo up in trees.

Photo 9.4 Hippo grazing surrounded by birds.
http://scienceray.com/biology/zoology/the-hippo/

9.11 Suitability to Captivity

Hippos make good zoo animals and are a favourite at zoos across the world (Eltringham, 1999). The Hippo breeds well, although there is definite room for improvement in husbandry, and their potential tameness makes them easy to handle (Eltringham, 1999). They do require a large pool as well as a terrestrial area for grazing and so are probably best suited to open range zoos. Being so large, Hippos can be expensive to accommodate and feed (Eltringham, 1999). Captive Hippos are generally robust and require little medical attention (Miller, 2003).

10 Breeding

10.1 Mating System

The largest male Hippos occupy narrow strips of water and land along the foreshore, of varying sizes. Here they defend exclusive mating rights but tolerate most subordinate males (Kingdon, 1997). Both female and subordinate male groupings are unstable in nature and can range in size from 2 to 150. The only stable unit is a female accompanied by up to four successive offspring (Kingdon, 1997).

Figure 10.1 Photo of Hippos mating at TWPZ, October 2007.

Mating in the hippo takes place in the water, with the female submerged for most of the time (Eltringham, 1999). It is a prolonged and noisy affair during which time only the male can be see rearing up out of the water with the only indication of what is taking place being the periodic emergence of the female's nostrils or head to draw breath as seen in Figure 10.1 (Eltringham, 1999).

10.2 Ease of Breeding

Hippos breed successfully in captivity (Miller, 2003). In the wild they are capable of breeding year round with seasonal peaks that coincide with peak rainfalls (Shefferly, 2001).

10.3 Reproductive Condition

10.3.1 Females

Obesity is a common problem in captive Hippos (Miller, 2003). There is the potential for females to encounter problems during pregnancy if they are already overweight and therefore it is important that they are in good body condition and at an optimal weight before breeding. Once pregnancy is determined, then dietary intake can be increased however the greatest metabolic need is actually during lactation (Eltringham, 1999). A female's readiness to mate is usually recognizable through the behaviour of the male. He

will show more interest in her and spend time near her. The female may turn and defecate towards the male Hippo's face.

10.3.2 Males

Males do not require being in any particular condition conducive to breeding, however it is also important for their weight to be managed for general health and longevity. They are capable of breeding year round.

10.4 Techniques Used to Control Breeding

Hippos breed very successfully in captivity and due to their size and longevity in captivity, effective contraception needs to be considered (Miller, 2003). Some forms of contraception in females have proved successful such as intra-muscular injections of Depo-Provera. Contraceptive implants have also been used successfully but are less common due to the need for sedation and surgery (Miller, 2003).

Surgical castration has been attempted in male Hippos; however efforts have been inhibited by the lack of ability to successfully locate the testes and the risk of anaesthesia in adult animals (Miller, 2003). More research is required before surgical or chemical castration of male Hippos can be recommended (Miller, 2003).

If the space permits, the safest and most effective means of contraception is to separate the male and house him in a different exhibit to the females.

10.5 Occurrence of Hybrids

There are two genera in the family Hippopotimidae, each with one living species; the Common Hippopotamus and the Pygmy Hippopotamus. The range and ecology of the two species is distinct and there are no records of inter-breeding between the two (Miller, 2003).

10.6 Timing of Breeding

In the wild, most mating occurs in February and August with most births occurring in October and April, months of maximum rainfall (Nowak, 1991).

10.7 Age at First Breeding and Last Breeding

Male Hippos reach puberty at between 4 and 11 years of age, with the average at 7.5 years (Eltringham, 1999). Studies have shown that the male's testis continue to grow throughout life, which may be related to the fact that the body weight in males also continue to increase with age. It is therefore likely that the male Hippo is fertile throughout life (Eltringham, 1999). A wild male Hippo however, would have to be much older before it could hope to defend a territory successfully and have a chance at breeding (Etringham, 1999).

Female Hippos reach sexual maturity at approximately 9 years with a range of 7 to 15 years of age (Eltringham, 1999). Unlike males, the females can begin to breed as soon as they are sexually mature and there does not seem to be any marked reduction in fertility with increasing age (Eltringham, 1999).

Average longevity in a protected wild population is around 41 years and it is thought Hippos can breed well into the later years of life (Nowack, 1991).

10.8 Ability to Breed Every Year

See 10.12

10.9 Ability to Breed More than Once Per Year

See 10.12

10.10 Nesting, Hollow or Other Requirements

As breeding can be an aggressive affair where the male forces the female into submission, there can be lots of jaw clashing and pushing (Kingdon, 1979). When introducing animals it is recommended to have a large area and objects such a large logs and stumps for the female and male to get away from each other if required. It is a good idea to give the female access to the area first to familiarise herself with the area and give her an advantage (Jones, 2007). It would be ideal to have partially submerged logs and a reed bed for the calf to hide in (Jones, 2007). In the wild the female would remove herself from the group before calving and remain in the water with the calf for the first few weeks before returning to the herd (Kingdon, 1979).

10.11 Breeding Diet

There are no particular dietary needs with regard to breeding as long as the animals are in good condition. If the female falls pregnant then her metabolic needs will increase and her diet will need to be increased. Depending on the Hippo, the female may need to have an increase in 4-6kg of hay during pregnancy and lactation.

10.12 Oestrous Cycle and Gestation Period

Female Hippos are polyestrous, spontaneous ovulators which are in estrus for 3 days (Nowak, 1991) and have an oestrous cycle of approximately 35 days (Miller, 2003). The gestation period of Hippos is known fairly accurately from observations of zoo animals and is 240 days, which is not quite 8 months (Eltringham, 1999). The average calving interval for Hippos is 2 years, allowing for an eight month gestation, a ten to twelve month lactation period and six month oestrous cycle (Eltringham, 1999). However, some

females may come into post partum oestrous and therefore have a calving interval of less than two years (Eltringham, 1999).

10.13 Litter Size

Normally a single calf is born, twins do occur although not very frequently (Elringham, 1999).

10.14 Age at Weaning

Suckling takes place either on land or in the water with the mother usually lying on her side. The calf is also able to suckle whilst under water by wrapping its tongue around the teat (Eltringham, 1999). Lactation lasts for about one year at which point most calves are fully weaned. Young Hippopotamuses will start to chew grass at about one month and to graze at five months of age (Kingdon, 1979).

10.15 Age of Removal from Parents

It is not uncommon to see a female closely followed by a file of up to four smaller Hippos, graded in size from a tiny infant to a three quarter grown young one (Kingdon, 1979). The calf may remain with the mother for a number of years but will leave before the onset of puberty which is 7.5 years in males and 9 years in females (Animal Encyclopedia, 2005).

10.16 Growth and Development

Newly born Hippos are relatively small (Figure 10.2) but can vary in weight from 25kg to 55kg (Kingdon, 1979). There is a record of a calf having reached 250kg at one year of age (Nowack, 1991). At birth, the Hippo will have milk teeth which consist of four pre-molars in each half jaw (Eltringham, 1999). These teeth are lost within the first few months of life (Eltringham, 1999). The female growth seems to plateau at around 24 years of age but there is little evidence that the male's growth levels off, suggesting that males continue to grow throughout life (Eltringham, 1999). Sexual maturity is discussed in 10.7.

Figure 10.2 Photo of newborn calf.

11 Artificial Rearing of Mammals

There is not a great amount of information available on the artificial rearing of the Hippopotamus. What little information is available, is also quite dated, from the 1970's and 80's. There is also a little information gathered from papers regarding the hand-rearing of the Pygmy Hippopotamus, *Choeropsis liberiensis* which may also apply to the rearing of the Common Hippo. The lack of information regarding this aspect of Hippo care is most likely due to the small amount of artificial rearing that has been undertaken for this species. In Australia at least, this may be due to a high occurrence of calf mortality that has occurred in the past.

11.1 Housing

In one case, a Pygmy Hippo calf was housed initially in a high-sided, sturdy box containing cloth bedding which had to be replaced regularly since it was frequently saturated by secretions from the calf's skin (Langdon and Schmidt, 1981).

In another case at Portland Zoo in 1975, a male calf was removed from his mother due to her injuring him. The calf was initially housed in an indoor stall 2.3 x 2.5m, with cement floor and walls. During the first month, the floor was covered with wood shavings and then a layer of straw to protect the calf's legs. At nine months, he was moved to a larger stall 3.3 x 4.6m (Wilson and Littlewood, 1977).

11.2 Temperature Requirements

In the case of a hand raised Pygmy Hippo in Melbourne Zoo in 1979, the calf was kept in an ambient temperature of 28˚C during the early stages of rearing due to having sustained injuries from the mother (Langdon and Schmidt, 1981).

Apart from this, there is no mention in the literature for temperature requirements of calves.

11.3 Diet and Feeding Routine

A Hippo calf at Melbourne Zoo in 1969 was raised on a formula consisting of 397g calf preparation and fresh eggs which were mixed into 3 ½ pints of sterile water. Her consumption averaged as following:

Week 1: 2.3 litres
Week 2: 4.55 litres
Week 3: 5.75 litres
Week 4: 6.8 litres
Week 5: 7.1 litres
Week 6: 9.5 litres
Week 7: 11.5 litres

This Hippo calf also refused to accept a bottle and was fed by immersing a keepers hand into a bowl of milk and allowing the calf to suck the fingers and therefore drink the milk (Weber, 1970).

In Portland Zoo in 1975 a Hippo calf was raised on a formula designed on an analysis of Hippo milk. This consisted of 3 litres of 3.8% cow's milk, 69g Purina protein and ABDEC vitamins. This amount was offered three times daily. Attempts to get the calf to accept a nipple were futile. The calf would suck the fingers of a keeper when they were immersed in milk and so he was fed from a bowl with the keepers hand in it. There were problems with this calf's diet and it suffered from diarrhea until being diagnosed with partial formula intolerance. At five months of age, the calf was switched to a milk free soy formula for human infants, which was readily accepted. It was given 2 litres mixed with an equal volume of water and Purina protein, three times daily. The calf was gradually weaned by adding zoo pellets to his formula starting at 6 months of age (Wilson and Littlewood, 1977).

A Pygmy Hippo born at The National Zoological Park in 1964 was fed initially on a formula of evaporated milk and water. As this calf would also refuse to suck from a bottle, the hand immersed in a bowl of milk method was used. The calf became constipated and the formula was changed to 3 parts evaporated milk, 2 parts water and a laxative granule. By the first months, the calf was fed three times daily; 650g in the morning, 227g at noon and 650g in the afternoon. At approximately 2 months, the calf was offered bread soaked into her formula as an addition. After this she was moved to a diet of 1 cup calf manna, 1 cup evaporated milk, 1 cup water, 1 banana, 1 apple and a handful of mixed greens. These were blended and poured onto the floor of the cage for her to eat. This diet was given until 18kg in weight, when the calf was gradually weaned onto grass and green food and then eventually hay and grain (Stroman and Slaughter, 1972).

A Pygmy Hippo calf at Melbourne Zoo in 1979 was given a domestic sows colostrum for the first 72 hours. During the first two weeks, the calf was given six feeds at four hour intervals. The feeds were reduced to five a day by the end of week 3 and four a day by the end of week 4 when the night feed was discontinued. The calf was fed a formula consisting of equal parts Carnation evaporated milk and boiled tap water. Pentavite liquid vitamin supplement was added at the end of week 1 and at the end of week four a gradually increasing amount of Roscoral Irondextran Complex was added as well. Intake averaged 1500mls over 24 hours for the first 3 weeks, increasing to 2500mls over 24 hours by the end of week 9. This calf would not accept the hand-sucking method and was eventually encouraged to use a fox nursing nipple successfully (Langdon and Schmidt, 1981).

11.4 Specific Requirements

In most of the literature found, it was noted that both Common Hippo and Pygmy Hippo calves would only defaecate in the water. It was always advised therefore that the calf

was allowed to swim daily to encourage defaecation and to aid with healthy skin (Weber, 1970) (Wilson and Littlewood, 1977) and (Stroman and Slaughter, 1972).

11.5 Data Recording

There was not a lot of accurate weight records found in the literature regarding the growth of the Common Hippo or Pygmy Hippo during hand rearing. If possible, it would be ideal to record this. He usual information recorded at Taronga Western Plains Zoo when hand rearing animals include:

Date of feed, time of feed, amount fed, daily weight, defecation/urination observed, medical treatments or vet checks and observations made regarding feeding.

11.6 Identification Methods

Hippos generally give birth to single young (Kingdon, 1979). Therefore it would be rare to be raising more than one calf at a time. Once the Hippo reached an age that it would be introduced back with other Hippos, an intrascapular microchip may be inserted under the skin. Generally Hippos are able to be identified through size, scars or pigmentation markings.

11.7 Hygiene

As with any species being hand reared it is important to maintain a high level of both personal hygiene as well as keeping the calf in a clean environment. Hands should be washed before and after handling or feeding the calf. The pool that the calf swims in should be cleaned daily as this will be where the defecation occurs. As with adult Hippos, the yard where the calf is housed should be cleaned daily. All feeding apparatus should be cleaned after use and disinfected in a sterilising solution.

11.8 Behavioural Considerations

Hippo calves would spend their first few weeks hidden in the water by their mother until they are strong enough to move on land. The calf would generally lie along the mothers back, just submerged below the surface (Kingdon, 1979). It is therefore important for the calf to spend time in the water each day. This also encourages the calf to defecate and is important for healthy skin (Wilson and Littlewood, 1977).

11.9 Use of Foster Species

There is no mention of foster species being used in the literature.

11.10 Weaning

This is discussed in more detail in 11.3 Diet and Feeding. Most calves are gradually weaned at around 6 months of age by introducing them first to soaked pellets and then hay and grains. Calves should have access to grass from an early stage, at around 2 months of age.

11.11 Rehabilitation and Release Procedures

12 Acknowledgements

I would like to acknowledge Anthony Dorrian, Taronga Western Plains Zoo for his assistance with hippo mating photos.

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15 Glossary

Amphibious: Living or able to live both on land and in water; belonging to both land and water.

Antihelminthic: An agent that destroys or causes the expulsion of parasitic intestinal worms. Also called *helminthagogue*, *helminthic*, *vermifuge*.

Apnea: The temporary absence or cessation of breathing.

Artiodactylid: A member of the order artiodactyla (even toed ungulates) of animals.

Ataxia: Loss of the ability to coordinate muscular movement.

Bradycardia: Slowness of the heart rate.

Caecum: Any structure or part that ends in a blind sac or pouch, especially the pouch that marks the beginning of the large intestine.

Caudomedial: Of or pertaining to the tail and the inside (nearest the middle) of an organ etc.

Cellulitis: A spreading inflammation of subcutaneous or connective tissue.

Clostridial vaccine: This vaccine works on the bacteria of the Clostridium genus that includes the organisms that cause tetanus and botulism.

Conjunctival sac: A gap or space formed between the eyelids and eyeball.

Dermatitis: Inflammation of the skin.

Dessication: Is the state of extreme dryness or the process of extreme drying.

Enterocolitis: Inflammation of both the small intestine and the colon.

Fistula: An abnormal duct or passage resulting from injury, disease, or a congenital disorder that connects an abscess, cavity, or hollow organ to the body surface or to another hollow organ.

Flehmen: The ritual of urine sniffing; a behavioral component of libido in the male animal. The animal appears to be carrying out a test for odor in the urine. He sniffs the urine or the perineum, then extends the head, dilates the nostrils, and lifts and curls the upper lip.

Haematology: The branch of medical science that studies the morphology of the blood and blood-forming tissues.

Herbivorous: Feeding on plants; plant-eating.

Hypotension: Abnormally low blood pressure.

Intrascapular: Between the scapulæ or shoulder blades.

Intubation: To insert a tube into (a hollow organ or body passage).

Mastitis: An infection of the breast. It usually only occurs in females who are breastfeeding their babies.

Midden: A dunghill or refuse heap.

Narcotization: To place under the influence of a narcotic drug.

Opthalmic: Of or relating to or resembling the eye.

Osteomyelitis: A usually bacterial infection of bone and bone marrow in which the resulting inflammation can lead to a reduction of blood supply to the bone.

Placentitis: Inflammation of the placenta; causes abortion or, by adhesions, retention of the placenta.

Porpoising: To leap or plunge like a porpoise 'penguins…porpoise out of the water'.

Post partum oestrus: When a female comes into oestrus directly after giving birth.

Ruminate: To chew the cud.

Sebaceous: Pertaining to, of the nature of, or resembling tallow or fat; fatty; greasy. 2. secreting a fatty substance.

Septicemia: A systemic disease caused by pathogenic organisms or their toxins in the bloodstream. Also called *blood poisoning*.

Sexual dimorphism: Is the systematic difference in form between individuals of different sex in the same species.

Subcutaneous: Beneath or under all the layers of the skin.

Termitary: A termite nest, often consisting of bits of earth and vegetable matter cemented together into a large mound.

Thermoregulate: The ability of an organism to keep its body temperature within certain boundaries, even when the surrounding temperature is very different.

Vasculitis: Inflammation of the blood vessels.

Venipuncture: Puncture of a vein, as for drawing blood, intravenous feeding, or administration of medicine.

Vomeronasal: Pertaining to the vomer and the nasal bone.

Wallowing: To roll the body about indolently or clumsily in or as if in water, snow, or mud.

16 Appendix 1 Annual Cycle of Maintenance for the *Hippopotamus amphibious*

Maintenance Task	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Scrub and disinfect concrete surfaces with F10.												
Remove and replace sandy beach substrate.												
Spray padlocks with Lanolin spray.												
Grease gate rollers.												
Dig out waste sump.												
Whipper snip grass areas between yards.												
Whipper snip grass on island.												
Clean out feed sheds.												
Dredge bottom of lake (every other year).												

Appendix 2 Hippo Behaviour Ethogram

Oestrus Detection

Sniffing	Males looking for mating opportunities may wander past females, sniffing at their backsides.
Urine testing	The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow **tail-paddling** when approached by a bull.
Courtship displays	The bull will pursue the female into the water until she turns and clashes jaws with him.

Mating Behaviours

Sniffing	Males looking for mating opportunities may wander past females, sniffing at their backsides.
Urine testing	The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow tail-paddling when approached by a bull.
Courtship displays	The bull will pursue the female into the water until she turns and clashes jaws with him.
Mating	Whilst in the water, the male will force the female into prostrate submission, whereupon he mounts her. The female's head is often forced underwater, and when she raises it to breathe, the bull may snap at her.
Wheeze-honking	The courtship is often punctuated by wheeze-honking which is the distinctive vocalization of the Hippo.

Aggression and related behaviours

Water-scooping	The hippo will be standing in the water with mouth open ('yawning') and will then use the bottom jaw to scoop up water and throw it into the air, usually in the direction of another animal. This is a threat display.
Explosive exhalation	Occurs above or below the water when the hippo exhales air from the nostrils quickly or in an explosive fashion.
Facing aggressor with mouth open	This is a defensive behaviour.
Turning tail	Turning around and backing away is a display of submission.
Lying prone	By lying prone, the hippo is submitting, similar to the posture of estrous females during copulation.
Chasing and Flight	Hot pursuits often occur once one animal decides to take flight, this can involve porpoising and lots of evasive swimming measures. This is often when deep cuts and gashes occur as the hippo that has taken flight has exposed it's body to the pursuer.
Porpoising	Usually occur during pursuits and fights. The Hippo dives through the water similar to a dolphin or seal, however using the bottom of the water body to push up from.
Roaring and grunting	Vocalisations used during displays of dominance.
Fighting	During fights there is lots of tusk clashing, rearing, lunging and pushing with the lower jaws engaged. The hippos will try to bite and slash at each other with their tusks.

Communication

Dung-showering	In males Hippos, this is an assertion of dominance and a form of territorial advertisement. In females or subordinate males, this behaviour usually occurs when they turn their rear towards the dominant bull and is done more slowly, often spashing water at the same time
Urine-testing	The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow **tail-paddling** when approached by a bull.
Yawning	A warning signal or threat display given by hippos, mouth is wide open showing the huge canine tusks.
Wheeze-honking	As noted above, occurs during mating, aggression and fights, and after any disturbances in the area.
Anti-predator behaviour	To avoid predators, Hippos will return to the water in a rapid fashion, often turning once in the water and showing their tusks in a yawning display.

Appendix 3 Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

COMPANY DETAILS MANUFACTURER:
AUSTRALIAN DISTRIBUTOR: Health and Hygiene (Pty) Ltd
COMPANY: Chemical Essentials (Pty) Ltd P O Box 347. Sunninghill 2157,
Address: 13 Abelia Str, Doncaster East, South Africa.
Victoria 3111 Tel:+27 11 474-1668
Emergency Telephone number:+03 9841 9901 Fax: +27 11 474-1670
Fax: +03 9841 9909 e-mail: info@healthandhygiene.co.za

IDENTIFICATION

PRODUCT NAME: **F10 SUPER CONCENTRATE DISINFECTANT** UN Number: None
D G Class: None
Hazchem code: None
Poisons Schedule: 5
HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA IN THE PACK CONCENTRATE ONLY (eyes and skin irritant)
USE: Biodegradable multi purpose Disinfectant for all hard surfaces, equipment and airspaces
PHYSICAL DESCRIPTION/PROPERTIES
Appearance: Clear, colourless liquid, with a slight natural odour.
Boiling Point: 110 ^{0}C
Vapour Pressure: Not known
Specific Gravity: 1.00
Flash Point: Not flammable
Flammability Limits: Not flammable
Solubility in water: Soluble
INGREDIENTS
CAS Number Quantity (w/w)
Benzalkonium Chloride 68424-85-1 5.4%
Biguanide 27083-27-8 0.4%
Ingredients not determined to be hazardous to 100%

HEALTH HAZARD INFORMATION

HEALTH EFFECTS:
Acute
SWALLOWED: Low. Substantial ingestion may cause irritation to mouth, throat and digestive tract.
EYE: Low. Will cause irritation but not serious damage.
SKIN: Low. Concentrate may act as mild degreasant to sensitive skin.
INHALED: Low. No significant hazard.
Chronic
INHALED: Low. No significant hazard

FIRST AID

SWALLOWED: DO NOT induce vomiting. Give milk or water to drink. Seek medical advice where necessary.
EYE: Rinse eyes with water. Seek medical advice where necessary.
SKIN: Wash affected area with soap and water.
INHALED: Non-toxic. Avoid long term inhalation of neat liquid. Remove to fresh air.
FIRST AID FACILITIES: Contact a doctor or Poison Information Centre (phone 131126)
ADVICE TO DOCTOR: Treat symptomatically

F10 SUPER CONCENTRATE DISINFECTANT

PRECAUTIONS FOR USE

EXPOSURE LIMITS: No data found
Engineering controls: None required
PERSONAL PROTECTION: Not required
FLAMMABILITY: Not Flammable

SAFE HANDLING INFORMATION

Storage and Transport: Store below 30 ^{0}C in dry conditions
SPILLS AND DISPOSAL: Soak up on an inert material e.g. dry earth and dispose of in an area approved by local authority by-laws. Flush small spills with copious amounts of water
FIRE/EXPLOSION HAZARD: The product is not flammable or explosive.
OTHER INFORMATION: Ensure good industrial hygiene.
DO NOT mix with soaps or other chemicals.

CONTACT POINT: Managing Director, +03 9841 9901
Chemical Essentials Pty Ltd

KEEP OUT OF THE REACH OF CHILDREN

Issue number: 2
Issue Date: August 2004

Material Safety Data Sheet

May be used to comply with OSHA's Hazard Communication Standard, 29 CFR 1910 1200. Standard must be consulted for specific requirements.

U.S. Department of Labor

Occupational Safety and Health Administration

(Non-Mandatory Form)

Form Approved

OMB No. 1218-0072

IDENTITY *(as Used on Label and List) Terra-Pure Wonder Clean, Wonder Soft, Wonder Care*	*Note: Blank spaces are not permitted. If any item is not applicable or no information is available, the space must be marked to indicate that.*

Section I

Manufacturer's name Terra-Pure	Emergency Telephone Number 914-310-7298
Address *(Number, Street, City, State and ZIP Code)* *277Mayflower Ave., New Rochelle, NY 10801*	Telephone Number for Information 914-380-4186
	 Date Prepared April 11, 2007
	Signature of Preparer *(optional)*

Section II—Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity, Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% (optional)

The contents and components of Wonder Clean, Wonder Soft or Wonder Care, contain no hazardous ingredients.

The products are all chemical free, non-toxic and hypoallergenic. While water is a main component, there are no chemical

Or artificial ingredients.

Section III—Physical/Chemical Characteristics

Boiling Point 212 degrees F.		Specific Gravity (H_20 = 1) 1	
Vapor Pressure (mm Hg) same as H_20		Melting Point N/A all liquid	
Vapor Density (AIR = 1) same as H_20		Evaporation Rate (Butyl Acetate = 1) same as H_20	

Solubility in Water 100 percent
Appearance and Odor -- Clear and odorless

Section IV—Fire and Explosion Hazard Data

Flash Point (Method Used) -- N/A non-flammable	Flammable Limits	LEL	UEL
Extinguishing Media			
Special Fire Fighting Procedures			
Unusual Fire and Explosion Hazards			

(Reproduce locally) OSHA 174 Sept. 1985

Appendix 4 Taronga Western Plains Zoo Hippo Breeding Action Plan

Zoological Parks Board of New South Wales

BREEDING ACTION PLAN
WESTERN PLAINS ZOO

Hippopotamus amphibius

DATE: Friday, 28 January 2011
SPECIES: Hippopotamus amphibius
IUCN Listing: Vulnerable A4cd
COMPILER: Rebecca Jones and Robert Clifford

1. CAPTIVE BREEDING HISTORY

At Western Plains Zoo

Hippopotamus amphibius has been exhibited at the zoo since 1976 when 1.2 animals were transferred from Taronga Zoo. Since then another 1.0 and 1.1 were transferred from Taronga Zoo in 1979 and 1992 respectively. Another 0.1 was traded from Adelaide Zoo in 1989. As of April 2007, Western Plains Zoo holds 2.4 Hippos.

Between March 1978 and May 1999, 15 calves have been born at Western Plains Zoo, however 8 of these calves died within the first 3 months due to injury from exhibit mates. Further information is given regarding the causes of death and actions taken to prevent further occurrences in Appendix 2.

The pairing of 1.0 Happy ARKS# 850026 and 0.1 Rumbin ARKS# 890046 has been successful in the past, they have had 4 calves previously, 0.1 is still surviving, all other calves were killed by exhibit mates. It is the recommendation of the 2007 ASMP Annual Report and Recommendations that 1.0 Happy be paired with 0.1 Rumbin – see AR&R Appendix 3.

2. BREEDING STRATEGY

2.1 Breeding Season

Hippopotamus amphibius is able to breed anytime of the year. In the wild, *Hippopotamus amphibius* experiences seasonal breeding peaks during February and August thus the birth of young coincides with the months of peak rainfall, October and April (Barlow, 2006). Australasian captive data (SPARKS dataset; total births: N = 110), indicate that in Australasia the peak birth months are February and March (16 and 15 births respectively); with calves also produced in every other month of the year (Barlow, 2006). Females have a three-day oestrus, during which time they are mated by the resident bull (Shefferly, 2005). Gestation period of *Hippopotamus amphibius* is approximately 8 months (Estes, 1991). Pairing the recommended *Hippopotamus amphibius* in April will give us a late spring or early summer calf, this way avoiding weather extremes for a newborn calf.

2.2 Group size / composition / sex ratio

Western Plains Zoo currently holds 2.4 *Hippopotamus amphibius*, all of which were captive born at Taronga, Western Plains or Adelaide Zoo.

2.3 Pairing (including introduction and duration)

The territories of hippos are established to defend mating rights and hippos tend not to be territorial away from the water (Eltringham, 1999). Mature bulls control 50-100m sections of a river or 250-500m of lakeshore and shallows as exclusive mating territories (Estes, 1991). As such, it could be assumed that 1.0 Happy would consider the whole water body that makes up the three exhibits AFX07, 11 and 06 as his territory. 1.0 Happy and 0.1 Rumbin have had full fence contact from 8 August 2006 until present time. In accordance with previous experience, 0.1 Rumbin will be given access to AFX07 to familiarise herself with the exhibit and give her a slight advantage. 10. Happy will then be introduced to her in this exhibit after a period of approximately 2 weeks. The introduction will be simple; on Monday 30th April, during the morning, the gates between the nightyards AFN59 and 60 (which are associated with exhibits AFX07 and 11) will be opened and left open to provide an escape route. The hippos will be closely monitored by keepers during the first few hours as this is generally when any expected aggression will occur (pers. Comm. John Davis). A request will also be made to the Zoo Friends Animal Watch to begin behavioural observations at this time as there will be keepers present to interpret behaviours. A checklist of behaviours will be provided to the Animal Watch volunteer to fill out over their observation period (Appendix 4).

1.0 Happy and 0.1 Rumbin will be left together for an initial period of 3 months, during which time matings will be observed and recorded. Initial faecal samples will be collected to gather a base level and then continually through the pregnancy (2-3 times per week). If no matings are observed within 70 days (2 oestrus cycles) after the first observed mating then pregnancy will be assumed. This will then be backed up by results found from the collection of faecal samples – pregnancy is expected to show an increased progesterone level.

After the birth of her last calf in 1999, which died from behavioural conditions (See Appendix 2), 0.1 Rumbin had some health problems associated with a troublesome birthing process and weakness in her back legs. Further information is being gathered regarding these health issues from personal accounts in order to assist post partum monitoring. 0.1 Rumbin's diet will be strictly monitored over the initial period to help her maintain a "safe" weight or condition, in consultation with vets this is considered to be ????. Measures will also be taken to keep her moving throughout the pregnancy through feeding her in different areas and encouraging her to walk across the large grassed area in exhibit AFX07.

The Breeding Action Plan recommends the following timeline for the proposed breeding event.

Timeframe	Action
Mid April 2007	Move 0.1 Rumbin from ASX11 into ASX07 to familiarise her with exhibit.
Late April 2007 (2 weeks later)	Introduce 1.0 Happy to 0.1 Rumbin in exhibit AFX07 . A Zoo Friends Animal Watch will be arranged for the duration of the introduction period. This person will monitor all behaviours and will be provided with the necessary information needed to confirm oestrus or mating behaviours.
Late June 2007	Separate breeding pair if pregnancy not assumed to prevent calf being born in colder months leading up to winter.

If pregnancy determined	A birthing plan and associated timeframes will be established prior to December 2007.
Month 5 of pregnancy	1.0 Happy to be removed from AFX07.
Month 5-6 of pregnancy	Maintenance work on the fence between AFX11 and AFX07 and planting of reeds in AFX07.
Month 6 of pregnancy	Birth plan completed. Advice of species coordinator regarding hand-rearing options confirmed.

2.4 Animal movements required

- 0.1 Rumbin will be moved into AFX07 to familiarise with exhibit.

- 1.0 Happy will be introduced into AFX07 with 0.1 Rumbin.

- Approximately 5-6 months into pregnancy, 1.0 Happy will be removed from AFX07.

2.5 Will artificial rearing be employed?

Seek species coordinator's advice by December 2007.

3. FEEDING REQUIREMENTS

3.1 Dietary changes needed for reproduction

At present 0.1 Rumbin is a lot leaner than in previous years (pers. comm John Davis), however, it is considered by the vets that would be beneficial for her to lose a little more weight before pregnancy. After consultation with vets, her meadow hay ration is to be ¾ of a large slab of meadow hay and her body condition is to be kept under observation in consultation with the vets. Once pregnancy has been determined her diet will be reviewed for amount.

4. DATA COLLECTION

- Faecal samples were to be taken from 0.1 Rumbin, however, samples were difficult to obtain and as no baseline level was able to be determined this was abandoned for this breeding.

- Observations of introduction from Zoo Friends Animal Watch using behavioural check sheet as per Appendix 4.

5. TARGET MILESTONES

- Institutional approval of Breeding Action Plan (April 2007).

- Introduction of Hippo pair (April 2007) as per AR&R (Appendix 3).

- End period of possible matings would be June 2007 to avoid the calf being born in cooler months of 2008.

- If pregnancy is confirmed, ie no mating observed for 2 oestrus cycles (70 days), 1.0 Happy will be left with 0.1 Rumbin for 6 months after first possible mating date, as long as no aggression is observed.

- Any maintenance to exhibit AFX07 will be completed once 1.0 Happy has been removed from the exhibit at approximately 6 months pregnancy. This will include any further work to the fence such as mesh fencing and the planting of reeds in the pond as a possible hiding place for the calf. The works are being left until this point in time to ensure that pregnancy is definite and to reduce wear and tear or damage from either hippo.

- A birthing plan will be set in place and milestones determined once pregnancy is confirmed.

APPENDIX I

Species ethogram

Oestrus detection

Sniffing	Males looking for mating opportunities may wander past females, sniffing at their backsides.
Urine testing	The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow tail-paddling when approached by a bull or backing up to the bull.
Courtship displays	The bull will pursue the female into the water until she turns and clashes jaws with him.

Mating behaviours

Sniffing	Males looking for mating opportunities may wander past females, sniffing at their backsides.
Urine testing	The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow tail-paddling when approached by a bull or backing up to the bull.
Courtship displays	The bull will pursue the female into the water until she turns and clashes jaws with him.
Mating	Whilst in the water, the male will force the female into prostrate submission, whereupon he mounts her. The female's head is often forced underwater, and when she raises it to breathe, the bull may snap at her.
Wheeze-honking	The courtship is often punctuated by the Hippos call, wheeze-honking.

Water trough
Vehicle Access Gates
Animal Shelter
Electric tape
KSA Keeper Service Area
★ Electric fence indicator
ASX01 solenoid
ASX02 solenoid
ASXo3 solenoid
Elephant solenoid

Aggression and related behaviours

Yawning or mouth open	A warning signal given by hippos, mouth is wide open showing the huge canine tusks.
Water-scooping	The hippo will be standing in the water with mouth open ('yawning') and will then use the bottom jaw to scoop up water and throw it into the air, usually in the direction of another animal. This is a threat display.
Explosive exhalation	Occurs above or below the water when the hippo exhales air from the nostrils quickly or in an explosive fashion.
Facing aggressor with mouth open	This is a defensive behaviour.
Turning tail	Turning around and backing away is a display of submission.
Lying prone	By lying prone, the hippo is submitting, similar to the posture of estrous females during copulation.
Chasing and Flight	Hot pursuits often occur once one animal decides to take flight, this can involve porpoising and lots of evasive swimming measures. This is often when deep cuts and gashes occur as the hippo that has taken flight has exposed it's body to the pursuer.
Porpoising	Usually occur during pursuits and fights. The Hippo dives through the water similar to a dolphin or seal.
Roaring and grunting	Vocalisations used during displays of dominance.
Fighting	During fights there is lots of tusk clashing, rearing, lunging and pushing with the lower jaws engaged. The hippos will try to bite and slash at each other with their tusks.

Behavioural events

Dung-showering	In males hippos, this is an assertion of dominance and a form of territorial advertisement.

In females or subordinate males, this behaviour usually occurs when they turn their rear towards the dominant bull and is done more slowly, often spashing water at the same time

Anti-predator behaviour — To avoid predators, hippos will return to the water in a rapid fashion, often turning once in the water and showing their tusks in a yawning display.

Communication

Dung-showering — In males hippos, this is an assertion of dominance and a form of territorial advertisement.

In females or subordinate males, this behaviour usually occurs when they turn their rear towards the dominant bull and is done more slowly, often splashing water at the same time

Urine testing — The vomeronasal organ in Hippos presumably functions to communicate the reproductive status of females and appears to function under water. Females may be observed urinating or slow tail-paddling when approached by a bull or backing up to the bull.

Yawning or mouth open — A warning signal or threat display given by hippos, mouth is wide open showing the huge canine tusks.

Wheeze-honking — As noted above, occurs during mating, aggression and fights, and after any disturbances in the area.

Bibliography:

Barlow, Suzie 2006. Captive Management Plan for Common Hippopotamus (Hippopotamus amphibius).

Eltringham, S.K. 1999. *The Hippos*. Academic Press. London, UK.

Estes, Richard Despard 1991. *The Behaviour Guide to African Mammals*. University of California Press, Ltd. London, England.

Shefferly, N. (2005). '*Hippopotamus amphibius'*

http://www.animaldiversity.ummz.umich.edu/site/accounts/information/Hippopotamus_amphibius Viewed 18 April, 2007.

APPENDIX 2 Details of Deaths of Hippo calves at WPZ

DATE	SIRE	DAM	CALF	DETAILS OF DEATH	ACTION TAKEN TO PREVENT RE-OCURRENCE
16.3.78	760004 'Toby'	760006 'Mumsy'	780004	Died 6.5.78, age 2 months. Death due to Environmenal or Behavioural Conditions.	0.1 Rumbin will be housed separately from 2 months before calf is due. Mesh fencing will be placed along the fence between AFX07 and other exhibits. Reeds will be planted as a hiding place for the calf and hopefully prevent any wandering.
19.2.90	760004 'Toby'	760005 'Suzie'	900023 'D190'	Stillborn after Suzie was observed fighting with another female hippo, Rumbin.	0.1 Rumbin will be housed separately from 2 months before calf is due
12.9.93	880037 'Ollie'	760005 'Suzie'	930091 'D293'	Born overnight, found dead the next morning in 1.0 Happy's yard.	0.1 Rumbin will be housed separately from 2 months before calf is due. Mesh fencing will be placed along the fence between AFX07 and other exhibits. Reeds will be planted as a hiding place for the calf and hopefully prevent any wandering.
19.2.93	920082 'Billy'	920083 'Lindy'	930018 'Obay'	Died 26.4.93, age 2 months. Cause of death was an injury from an exhibit mate.	As above.
17.11.96	**850026 'Happy'**	**890046 'Rumbin'**	**960159 'Kariba'**	**Died 19.11.96, age 2 days. Death was due to environmental or behavioural conditions.**	**As above.**
29.7.98	**850026 'Happy'**	**890046 'Rumbin'**	**980117 'D198'**	**Died 16.8.98, age 18 days. Death due to injury from exhibit mate.**	**As above.**
14.8.98	880037 'Ollie'	760005 'Suzie'	980119 'D298'	Died 16.8.98, age 2 days. Death due to injury from exhibit mate.	As above.

24.5.99	**850026 'Happy'**	**890046 'Rumbin'**	**990148 'Timbuktu'**	**Died 26.5.99, age 2 days. Was found on the ground shaking and was taken to VQC where it died. Death was determined to be due to environmental or behavioural conditions.**	**As above.**

APPENDIX 3

*16.1 Captive Management Plan for Common Hippopotamus (*Hippopotamus amphibius*)*

16.21. Introduction

- ***Taxon information***

Taxon (*scientific name*)

16.2.1.1 Hippopotamus amphibius

Common name

16.2.1.1.1.1 Common hippopotamus

IUCN status — Not listed (under review 2005)

CITES listing

16.2.1.1.1.2 CITES II

Other relevant listings

16.2.1.1.1.3 VPC 2

TAG

16.2.1.1.1.4 ASMP Artiodactyl TAG

Captive management unit — Species (Kingdon, 1997)

Scope of managed population — Captive population in ARAZPA institutions

Species Co-ordinator:

16.2.1.1.1.5 Suzy Barlow

Contact details: *Email:* sbarlow@zoo.org.au

Fax: 03 9285 9360

Phone: 03 9285 9362

Document prepared by:

16.2.1.1.1.6 Suzy Barlow

Last updated: March 2006

- ***Rationale***

1.1.1. The Common Hippopotamus is an iconic species that has been managed in our Australasian regional collections for over 80 years. The display of this species supports the illustration of biodiversity and creates the opportunity for our institutions to interpret the importance of waterways management and water conservation. Additionally this species has strong ties with African savannah themes, which are especially relevant for the region's open range zoos. This was the preferred hippopotamus species identified for regional management at the 2005 meeting of the Artiodactyl Taxon Advisory Group.

- ***Aims of captive management***

The aim of captive management is to ensure the persistence of a captive population that:

- conserves the behavioural repertoire of the species;
- conserves at least 90% of genetic diversity found in the wild source population (contingent on the ability to resume importation)
- can support the development and documentation of husbandry techniques for the species;
- supports regional education efforts;
- supports the illustration of biodiversity

- ***Additional program aims***

In addition, the program aims to:

- document appropriate husbandry techniques for increasing survival of juvenile hippos.
- document appropriate management techniques for managing male calves in the region in collaboration with the ARAZPA veterinary specialist group.

- ***Program goals***

Population management: (Note that these goals are contingent on the ability to import being resumed).	*Ensure persistence of display population at planned size for 50 years. Reduce inbreeding below threshold of 0.125. Increase and maintain genetic diversity at 90% of that in the wild source population.*
Husbandry:	*Reduce juvenile mortality rates, document introduction methods.*
Male management:	*Develop 'surplus' male management plan with ARAZPA Veterinary Group for approval by all current and planned holders.*

- ***Program type***

Current:	No regional program
Proposed:	Population Management Program

- ***Population management level***

Current:	Management level 3
Proposed:	Management level 1a

- ***History in captivity***

From the available regional animal records, the first specimen brought to Australasia was a wild caught female imported to Adelaide Zoo in approximately November 1900. Further wild caught animals were imported to Melbourne (1920s), Auckland (1930s) and Sydney (1950s). All these animals are recorded as wild caught in Kenya and 'Africa', and were purchased via animal dealers. The current Australasian population is descended from 6 of the 9 reported wild caught animals.

The species is capable of breeding all year round, but in the wild experiences seasonal breeding peaks during February and August. Thus the birth of young coincides with the months of peak rainfall, October and April. Females have a three-day oestrus,

during which time they are mated by the resident bull. (Shefferly, 2005). Australasian captive data (SPARKS dataset; total births: N = 110), indicate that in Australasia the peak birth months are February and March (16 and 15 births respectively); with calves also produced in every other month of the year (average of 6 births each month except July with only 3 recorded). Gestation period is 227 – 240 days.

Common Hippopotamuses breed readily in captivity. In current living captive populations in North America (32.49), Europe (58.82.6) and Australasia (5.10) there is a bias in the sex ratio of adult animals in favour of females (ISIS, 2005). It is not clear how this has been reached, given that the sex ratio at birth is at parity. However, infant mortality is recorded at 55% (under 30 days) in the Australasian population, mostly due to calves being killed by 'exhibit mate', (Common Hippopotamus SPARKS dataset, post mortem codes). This is presumably caused by factors such as small enclosure sizes (traditional in city zoos); no separation of females from conspecifics at predicted parturition date as a result of failure to anticipate births, or facilities not allowing separation, (females in the wild isolate prior to calving, on land or in shallow water, rejoining the herd after 10-14 days, (Estes, 1991); and contraceptive issues faced by this species in captivity. Kingdon (1984) states that hippo groups are unstable and split up regularly in the wild. Adult males may be tolerant but can be extremely aggressive towards other individuals (and have been known to attack and kill any other hippo nearby, including young adults). Females can also be very aggressive when they have young calves; in the wild deaths from territorial fights are not infrequent. In captivity this results in issues of incompatibility and means it is difficult to introduce animals to each other, with such introductions carrying a very high risk of aggressive interactions, which has resulted in deaths in our regional zoos in the past.

In the ASMP captive hippopotamus population there has been a failure to address the issue of the production (and subsequent holding) of male calves, which the current Species Co-ordinator will attempt to address in collaboration with the ARAZPA Veterinary Advisory Group and in consultation with holders.

- ***Status of wild populations***

In 2004, the Hippo Subgroup of the SSC's Pigs, Peccaries and Hippos Specialist Group, completed a population and status assessment of the Common and Pygmy hippopotamus, which highlighted some worrying trends in both species. (IUCN, SSC 2005). The Common Hippopotamus is found in 29 countries in sub-saharan Africa, and while considered reasonably secure in its principal strongholds of eastern and southern Africa, it is in severe decline in several range countries.

'At the time of the last completed assessment of hippo populations in 1994, the Common hippopotamus was described as widespread and secure, with an estimated population of 160,000 animals…Unfortunately since then, there have been substantial changes for the worse in several key countries which suggest a revision of its conservation status is necessary'. (www.iucn.org; 'Future of Africa's Wetland Icons Hangs in the Balance').

The total population is now estimated to be as low as 125,000. Hippo populations have been devastated as a result of unregulated hunting for bushmeat and for ivory (hippo canine teeth). There is also a rise in the number of hippo-human conflicts, as human pressure on freshwater resources and habitats increases. As a result the IUCN conservation status for the species is under review.

- ***Programs in other regions***

Region	*Program type*	*Population size (date)*	*Coordinator, institution*
N. America	Studbook	121 living (23.3.2004)	John Davis, Columbia

- ***Tools for analysis***

Package	*Version*	*Author, date*
SPARKS	1.52	ISIS, 26/8/2002
PM2000	1.202	J.P Pollak, R.C. Lacy, J.D. Ballou. 2000. Chicago Zoological Society

- ***Studbook data***

Studbook compiled by:	*Suzy Barlow*
Scope of data:	Australasia
Date first compiled:	2002 (D. Kroeger, Dubbo)
Data now current to:	31 December 2005

16.2.1.1.2 Table 1: Overview of studbook data

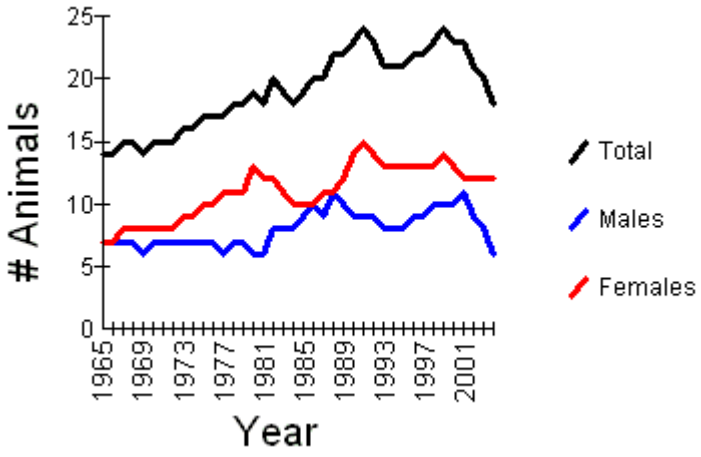
		Living Specimens		**Total studbook**	
		No. of specimens	**% of total living**	**No. of specimens**	**% of total**
Totals	Number of specimens	18	100%	114	
Sex	Females	12	67%	56	49%
	Males	6	33%	45	39%
	Unknown	0	0	13	12%
Origins	Captive born	18	100%	105	92%
	Wild born	0	0	9	8%
	Unknown origin	0	0	0	0
Parentage	Parents known (identified by studbook no. or as 'WILD')	16.2.1.1.2.1	N/A	227	99.5 %
	Multiple possible parents (listed as 'MULT…')	N/A	N/A	N/A	0
	Parents unknown (listed as 'UNK')	N/A	N/A	1	0.5%
Birth dates	Known or Estimated	18	100%	114	100 %

1. Demographic Review

- ***Annual census***

Data restricted to: Population in ARAZPA institutions

Graph 1: Annual census of the captive population of Common Hippopotamus



- ***Recent developments in the captive population***

Data restricted to animals held by ASMP participants from 01.01.2001 to 31.12.2005

Table 2. Developments in the captive population of Common Hippopotamus 2001 – 2005

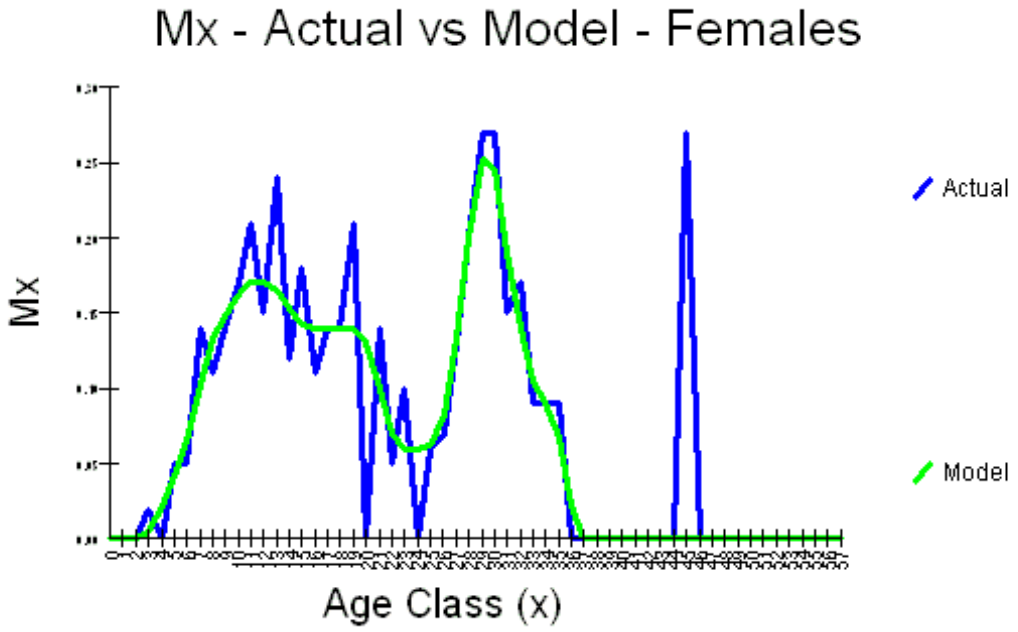
	2001	2002	2003	2004	2005	Totals
Population size at 1st Jan.	8.11	8.11	7.10	5.10	5.10	5.10
Acquisitions:						
Births	1.1	0.1	0.1	0.0	0.0	1.3
Captures from wild	0	0	0	0	0	0
Imports	0	0	0	0	0	0
Total acquisitions	**1.1**	**0.1**	**0.1**	**0**	**0**	**1.3**
Dispositions:						
Deaths (total no.)	1.1	1.2	2.1	0.0	0.0	4.4
(Neonatal deaths)	*(1.0)*	*(0.1)*	*(0)*	*(0)*	*(0)*	*(1.1)*
Exports	0	0	0	0	0	0
Releases	0	0	0	0	0	0
Lost-to-follow-up	0	0	0	0	0	0
Total dispositions	**1.1**	**1.2**	**2.1**	**0**	**0**	**4.4**
Population size at 31st Dec.	8.11	7.10	5.10	5.10	5.10	5.10*

***Population size at 31 December 2005**

- ***Reproduction***

Reproductive cycle:	*Tends to be seasonal in the wild with births in April and October (Shefferly, 2005). In the Australasian captive population peak birth months are February and March, though births can occur at any time of year.*
Social structure:	*Group living, but groups are unstable (Kingdon, 1984.)*
Mating behaviour:	*Polygynous. The territorial male breeds. (Kingdon, 1984.)*
Litter size	*Mean = one calf* *Range = 1-2*

Graph 2. Age-specific fecundity in the captive population of female Common Hippopotamus



Graph 3: Age-specific fecundity in the captive population of male Common Hippopotamus

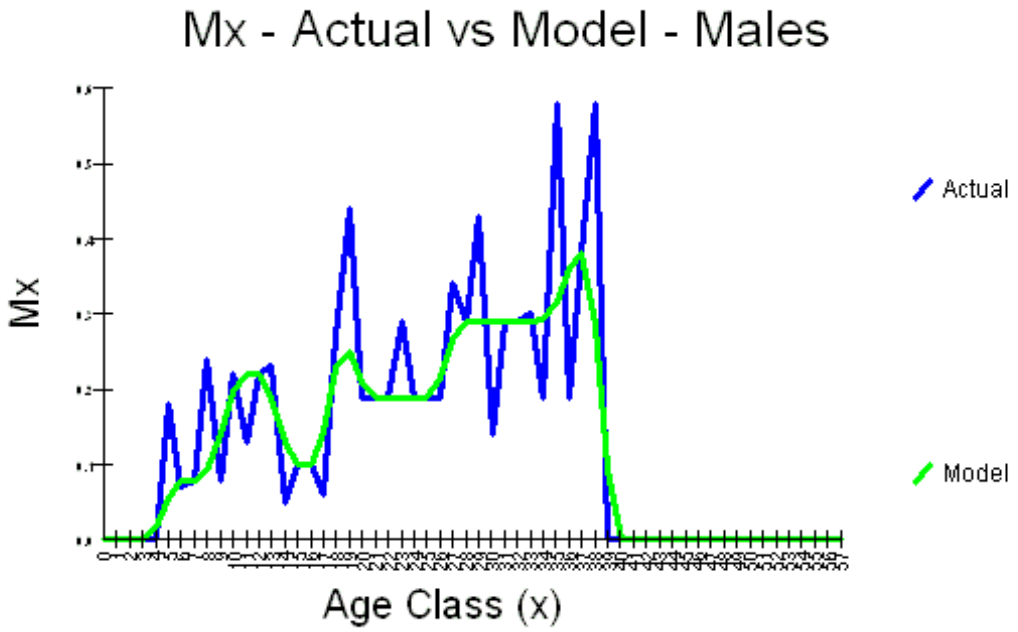
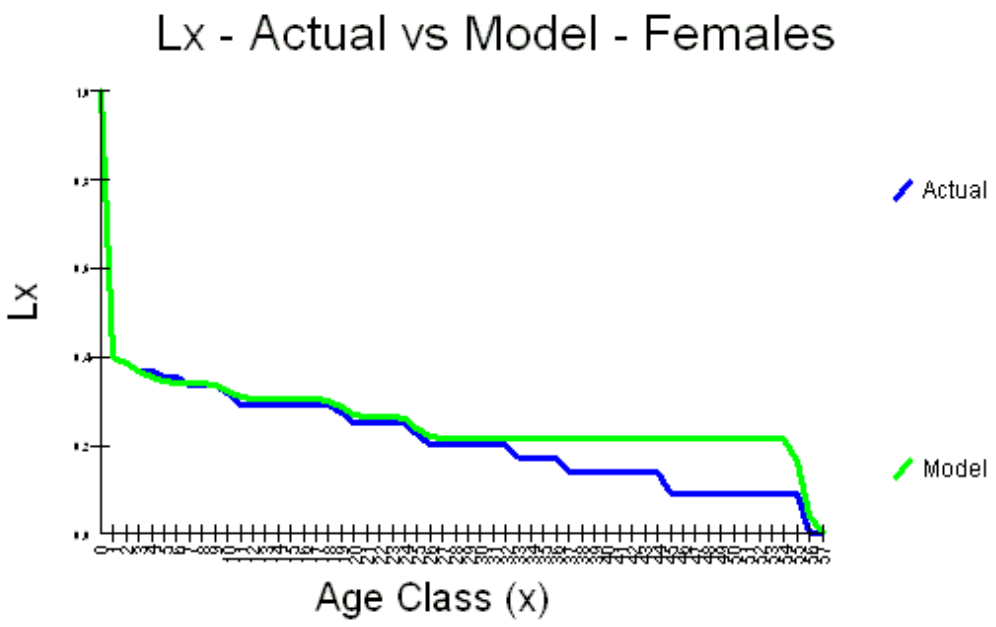


Table 3: Reproductive parameters from studbook data

Females	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	5 – 35 years
Age range of peak reproduction (age classes for which average (median) Mx value is exceeded)	7 – 32 years
Males	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	5 – 38 years
Age range of peak reproduction (age classes for which average (median) Mx value is exceeded)	8 – 38 years

- ***Mortality***

Graph 4. Age-specific survivorship of female Common Hippopotamus in the ASMP captive population



Graph 5. Age-specific survivorship of male Common Hippopotamus in the ASMP captive population

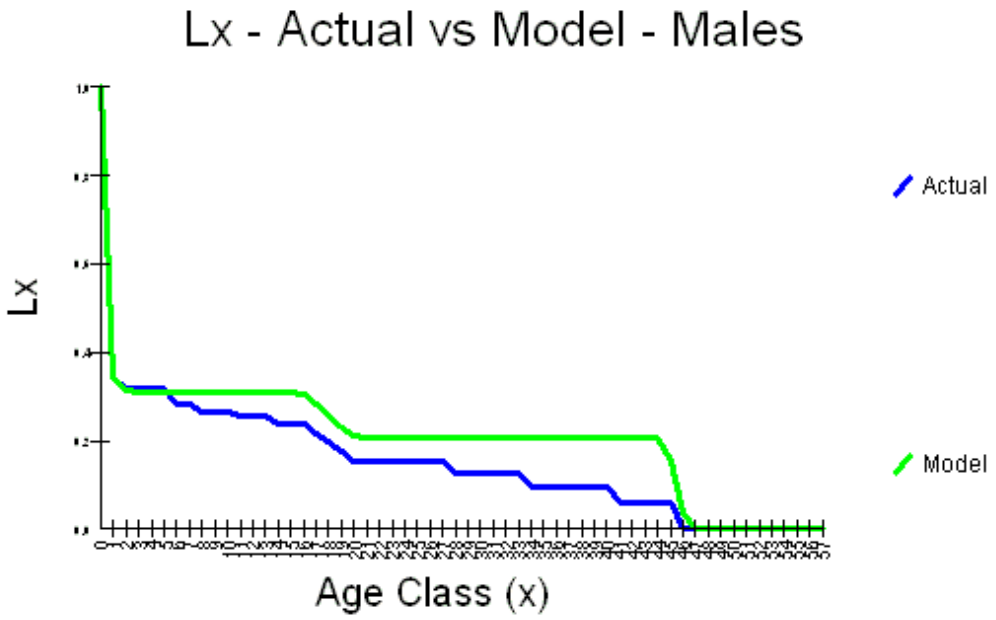


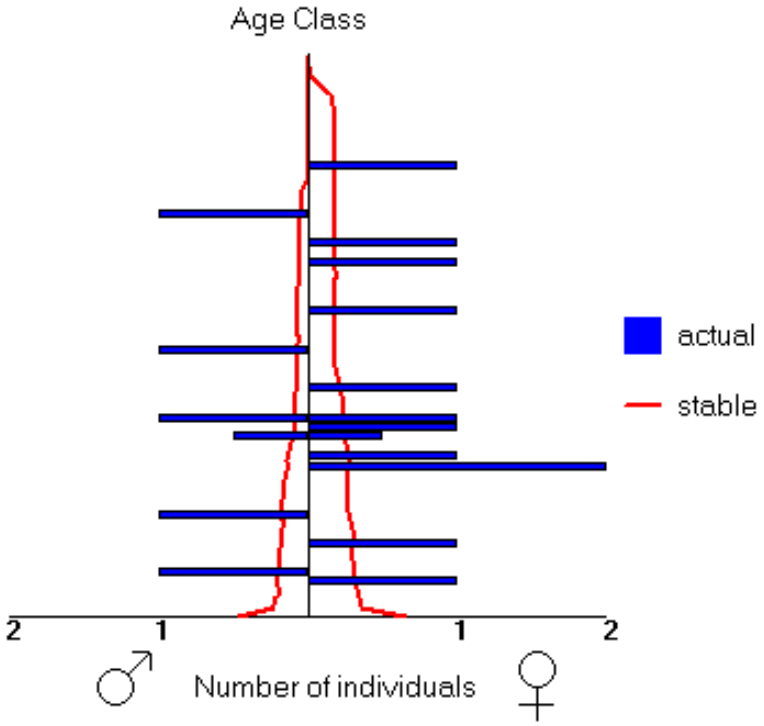
Table 4. Summary of mortality data from studbook

Females	
% juvenile mortality (females < 1 years old)	55% both sexes
Average life expectancy of adults *(median age at death of animals surviving juvenile age classes)*	9 years
Maximum longevity *(age at death of oldest animal in studbook)*	55 years
Males	
% juvenile mortality (males < 1 years old)	55% both sexes
Average life expectancy of adults *(median age at death of animals surviving juvenile age classes)*	16 years
Maximum longevity *(age at death of oldest animal in studbook)*	45 years

- ***Age structure and sex ratio***

Data restricted to: living animals held by ASMP participants at 31 December 2005

Figure 1: Age Pyramid for living population.



NB. One male neutered

2. Genetic status

Table 2. Animals excluded from analyses

Post-reproductive animals:			
Females were considered post-reproductive at:			*34 years*
Males were considered post-reproductive at:			*38 years*
1025 (M) at Adelaide (41 years); 1029 (F) at Adelaide (38 years); 1017 (F) at Auckland (46 years) and 1037 (F) at Dubbo (36 years).			
Animals at non-participating institutions:			
Animals at the following institutions were excluded from the analysis as they are not considered to form part of the managed population: Mareeba Wild Animal Park (Queensland, Australia) – previously at Tipperary Station 1135 (F) at Mareeba; 1144 (F) at Mareeba, 1179 (M) at Mareeba.			
Additional animals excluded:			
Studbook no.	***Local ID***	***Sex***	***Reason removed from analysis***
1076	MH0188	m	Neutered (Auckland male 'Fudge')

Table 3. Pedigree assumptions

No. of gene drop iterations:	10,000
Percentage of ancestry traced to founders *(before pedigree assumptions are factored in)*:	100%
Number of parental assumptions required for analysis	N/A
Data restricted to: Living animals held by ASMP participants at 31 December 2005	

Table 4: Genetic summary of the descendent captive population of Common hippopotamus at 31 December 2005

	Current	***Potential***
Founders	6	0
Gene Diversity (fraction of source gene diversity retained)	0.7441	0.8460
Founder Genome Equivalents (FGE's)	1.95	3.25
Percent of potential gene diversity achieved (existing GD/ potential GD x 100)	87.9%	
Mean Inbreeding coefficient	0.166	
Range of Inbreeding coefficients	0 – 0.3125	
Average Mean Kinship (MK)	0.2559	

3. Population Projections

- ***Planned regional population size (ARAZPA Reg. Census & Plan 2005)***

Zoo	**Current**			**Planned**			**Time line**
	males	**females**	**Unk.**	**males**	**females**	**Undet.**	
Adelaide Zoo	1	1	0	1	1	0	Maintain
Auckland Zoological Park	1	2	0	1	2	0	Maintain; male castrated
Crocodylus	0	0	0	1	1	0	Acquire long term > 2007
Monarto Zoological Park	0	0	0	0	3	0	Acquire long term
Werribee	1	3		1	5	2	Acquire long term
Western Plains Zoo	2	4		2	4		Maintain
TOTAL	5	10		6	16	2	

- ***Implications of planned population size***

Table 5. Number of pairings and offspring required to meet population targets over next 5 years.(*NB clearly not feasible with current population*).

Current population size:	5.10
Target population size in 5 years:	6.16.2
Growth rate required:	1.09
Average number per litter:	1
Probability pair breeds:	50% (estimated)

	2006	2007	2008	2009	2010
Expected number births needed:	2.3	3.6	4.9	6.2	7.2
Number pairs required:	4.7	7.4	9.8	12.6	14.4

4. Management Strategy

- ***Target population characteristics***

Goals for population management:	*Persistence for 50 years/retention of as much gene diversity as possible given low GD of current population (without importation)*
Available captive space:	24 spaces in next 5 years
Immigration required	Yes – importation required. A minimum of 1.1 in the next 10 year period.. This is entirely contingent on sufficient regional breeding spaces being made available.
Source of new founders	Import from USA – but no current IRA for Australia or IHS for New Zealand

- ***Import Risk Assessment (Australia) and Import Health Standard (New Zealand) Issues***

This species cannot currently be imported to either Australia or New Zealand (though further follow up is required to find out if hippos can be transferred between the two countries). The Australian Bovidae Import Risk Assessment (IRA) was suspended in 2001 following outbreaks of Foot and Mouth Disease (FMD) and Bovine Spongiform Encephalopathy (BSE) overseas, with our authorities currently incorporating hippopotamuses under this IRA. New Zealand has recently developed Import Health Standards for Antelopes (IHSs), but have no standards for the importation of hippopotamuses.

At the 2005 meeting of the Artiodactyl TAG, this was one of the species listed as a high priority for potential regional import; to be discussed at initial meetings between ARAZPA and BioSecurity Australia.

- ***Breeding management/husbandry issues***

Any facilities planning to upgrade or construct new facilities for this species are strongly recommended to seek regional and international advice in relation to designing facilities that will meet the management requirements of Common Hippopotamuses. Facilities need to take into account the ability to separate animals post mating, and to be flexible enough to cope with safely introducing or separating individuals. In all cases this requires appropriate off exhibit facilities and more than one water-body.

It should be noted, that only Dubbo and Werribee are currently in a position to attempt breeding, with realistic hopes of successful rearing, due to the facilities at each institution. Given the genetic status of the population, and the lack of ability to import, there can be no guarantee of animals being available to meet display requirements for those facilities listing to acquire within the next 5 year period.

- ***Demographic management strategy***

Note: this is the preferred demographic strategy for management. It will not be possible to implement this strategy unless importation is resumed and regional carrying and breeding capacities increase.

The number of breeding pairs each year/season will be determined with the aim of maintaining planned numbers and avoiding the production of surplus. The number of breeding pairs recommended each (year/season) will be selected with reference to:

1. available space (if population is not at capacity)
2. DEMOG/PM2000 analysis of reproductive rate required to maintain zero population growth (if population at capacity)

- ***Genetic management strategy***

Note: this is the preferred genetic management strategy for the region. It will not be possible to implement this strategy unless importation is resumed and regional carrying and breeding capacities increase.

Selection of breeding pairs is to be aimed at reducing the rate at which gene diversity is lost and inbreeding is accumulated within the population. Optimal breeding pairs will be selected based on the following criteria (in order of importance):

- Males aged at least 5 yrs, females aged at least 5 yrs
- Low mean kinship values relative to the population average
- Like mean kinship values between prospective pairs
- Avoiding inbreeding levels equal to or above 0.125 – not possible with current population (without importation)
- All else being equal, older animals before younger animals

5. Program administration

Planned frequency of recommendations:	*Annually*
Progress reported:	*Annually*
Program review:	To be reviewed annually until the ability to import is resumed, after which 5 year reviews should be sufficient.

Management team

Name	Responsibility	Institution	Email
Suzy Barlow	Species Co-ordinator	Melbourne Zoo	sbarlow@zoo.org.au
Benn Bryant	Veterinary advisor	Western Plains Zoo	bbryant@zoo.nsw.gov.au
Davin Kroeger	Husbandry advisor	Werribee's Open Range Zoo	dkroeger@zoo.org.au

6. Appendices

- ***Life tables***

Males (Australasian population)

r = 0.0106
lambda = 1.0106
T = 20.64
N = 3.00
N(at 20 yrs) = 3.71

"Age (x)"	"Qx"	"Px"	"lx"	"Mx"	"Risk (Qx)"	"Risk (Mx)"
0	0.660	0.340	1.000	0.000	47.000	17.300
1	0.060	0.940	0.340	0.000	17.000	16.100
2	0.000	1.000	0.320	0.000	16.400	16.400
3	0.000	1.000	0.320	0.000	16.800	16.800
4	0.000	1.000	0.320	0.000	17.500	17.500
5	0.110	0.890	0.320	0.180	17.500	15.800
6	0.000	1.000	0.284	0.070	15.500	15.500
7	0.060	0.940	0.284	0.080	15.500	14.800
8	0.000	1.000	0.267	0.240	14.500	14.500
9	0.000	1.000	0.267	0.080	14.200	14.200
10	0.040	0.960	0.267	0.220	13.500	13.400
11	0.000	1.000	0.257	0.130	13.000	13.000
12	0.000	1.000	0.257	0.220	13.000	13.000
13	0.080	0.920	0.257	0.230	13.000	12.800
14	0.000	1.000	0.236	0.050	12.000	12.000
15	0.000	1.000	0.236	0.100	12.000	12.000
16	0.080	0.920	0.236	0.100	12.000	11.400
17	0.090	0.910	0.217	0.060	10.800	10.200
18	0.110	0.890	0.198	0.270	9.400	8.500
19	0.130	0.870	0.176	0.440	8.000	7.900
20	0.000	1.000	0.153	0.190	6.000	6.000
21	0.000	1.000	0.153	0.190	6.000	6.000
22	0.000	1.000	0.153	0.190	6.000	6.000
23	0.000	1.000	0.153	0.290	6.000	6.000
24	0.000	1.000	0.153	0.190	6.000	6.000
25	0.000	1.000	0.153	0.190	6.000	6.000
26	0.000	1.000	0.153	0.190	6.000	6.000
27	0.170	0.830	0.153	0.340	5.800	5.100
28	0.000	1.000	0.127	0.290	4.000	4.000
29	0.000	1.000	0.127	0.430	4.000	4.000
30	0.000	1.000	0.127	0.140	4.000	4.000
31	0.000	1.000	0.127	0.290	4.000	4.000
32	0.000	1.000	0.127	0.290	4.000	4.000
33	0.250	0.750	0.127	0.300	4.000	3.900
34	0.000	1.000	0.095	0.190	3.000	3.000
35	0.000	1.000	0.095	0.580	3.000	3.000
36	0.000	1.000	0.095	0.190	3.000	3.000

37 0.000 1.000 0.095 0.380 3.000 3.000
38 0.000 1.000 0.095 0.580 3.000 3.000
39 0.000 1.000 0.095 0.000 3.000 3.000
40 0.390 0.610 0.095 0.000 2.600 2.000
41 0.000 1.000 0.058 0.000 1.000 1.000
42 0.000 1.000 0.058 0.000 1.000 1.000
43 0.000 1.000 0.058 0.000 1.000 1.000
44 0.000 1.000 0.058 0.000 1.000 1.000
45 1.000 0.000 0.058 0.000 1.000 0.600
46 1.000 0.000 0.000 0.000 0.000 0.000
47 1.000 0.000 0.000 0.000 0.000 0.000
48 1.000 0.000 0.000 0.000 0.000 0.000

30-day mortality (both sexes): 56.7% (59 of 104 neonates)

16.2.1.1.2.1.1.2 Males (Model data) Australasian studbook

r = 0.0239
lambda = 1.0242
T = 21.41
N = 3.00
N(at 20 yrs) = 4.84

"Age (x)" "Qx" "Px" "lx" "Mx" "Vx" "Ex" "Risk (Qx)" "Risk (Mx)"
0 0.660 0.340 1.000 0.000 1.493 17.336 47.000 17.300
1 0.075 0.925 0.340 0.000 3.130 33.446 17.000 16.100
2 0.015 0.985 0.315 0.000 3.360 34.016 16.400 16.400
3 0.000 1.000 0.310 0.000 3.468 33.268 16.800 16.800
4 0.000 1.000 0.310 0.018 3.551 32.268 17.500 17.500
5 0.000 1.000 0.310 0.055 3.619 31.268 17.500 15.800
6 0.000 1.000 0.310 0.078 3.650 30.268 15.500 15.500
7 0.000 1.000 0.310 0.080 3.659 29.268 15.500 14.800
8 0.000 1.000 0.310 0.093 3.666 28.268 14.500 14.500
9 0.000 1.000 0.310 0.140 3.659 27.268 14.200 14.200
10 0.000 1.000 0.310 0.198 3.604 26.268 13.500 13.400
11 0.000 1.000 0.310 0.220 3.489 25.268 13.000 13.000
12 0.000 1.000 0.310 0.220 3.348 24.268 13.000 13.000
13 0.000 1.000 0.310 0.190 3.204 23.268 13.000 12.800
14 0.000 1.000 0.310 0.130 3.087 22.268 12.000 12.000
15 0.020 0.980 0.310 0.100 3.059 21.482 12.000 12.000
16 0.063 0.938 0.304 0.100 3.160 21.359 12.000 11.400
17 0.092 0.908 0.285 0.143 3.395 22.058 10.800 10.200
18 0.105 0.895 0.258 0.228 3.695 23.357 9.400 8.500
19 0.082 0.918 0.231 0.250 3.921 24.687 8.000 7.900
20 0.027 0.973 0.212 0.210 3.984 25.097 6.000 6.000
21 0.000 1.000 0.206 0.190 3.919 24.438 6.000 6.000
22 0.000 1.000 0.206 0.190 3.820 23.438 6.000 6.000
23 0.000 1.000 0.206 0.190 3.717 22.438 6.000 6.000
24 0.000 1.000 0.206 0.190 3.612 21.438 6.000 6.000

25	0.000	1.000	0.206	0.190	3.505	20.438	6.000	6.000
26	0.000	1.000	0.206	0.215	3.395	19.438	6.000	6.000
27	0.000	1.000	0.206	0.265	3.257	18.438	5.800	5.100
28	0.000	1.000	0.206	0.290	3.064	17.438	4.000	4.000
29	0.000	1.000	0.206	0.290	2.841	16.438	4.000	4.000
30	0.000	1.000	0.206	0.290	2.613	15.438	4.000	4.000
31	0.000	1.000	0.206	0.290	2.379	14.438	4.000	4.000
32	0.000	1.000	0.206	0.290	2.139	13.438	4.000	4.000
33	0.000	1.000	0.206	0.290	1.894	12.438	4.000	3.900
34	0.000	1.000	0.206	0.293	1.643	11.438	3.000	3.000
35	0.000	1.000	0.206	0.318	1.383	10.438	3.000	3.000
36	0.000	1.000	0.206	0.360	1.091	9.438	3.000	3.000
37	0.000	1.000	0.206	0.380	0.749	8.438	3.000	3.000
38	0.000	1.000	0.206	0.285	0.378	7.438	3.000	3.000
39	0.000	1.000	0.206	0.095	0.095	6.438	3.000	3.000
40	0.000	1.000	0.206	0.000	0.000	5.438	2.600	2.000
41	0.000	1.000	0.206	0.000	0.000	4.438	1.000	1.000
42	0.000	1.000	0.206	0.000	0.000	3.438	1.000	1.000
43	0.000	1.000	0.206	0.000	0.000	2.438	1.000	1.000
44	0.250	0.750	0.206	0.000	0.000	1.643	1.000	1.000
45	0.750	0.250	0.155	0.000	0.000	1.200	1.000	0.600
46	1.000	0.000	0.039	0.000	0.000	1.000	0.000	0.000
47	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
48	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Females (Australasian population)

r = 0.0106
lambda = 1.0023
T = 19.10
N = 7.00
N(at 20 yrs) = 7.33

"Age (x)"	"Qx"	"Px"	"lx"	"Mx"	"Risk (Qx)"	"Risk (Mx)"
0	0.600	0.400	1.000	0.000	58.000	25.400
1	0.000	1.000	0.400	0.000	22.700	22.700
2	0.090	0.910	0.400	0.000	23.300	21.800
3	0.000	1.000	0.364	0.020	22.300	22.300
4	0.040	0.960	0.364	0.000	22.500	21.800
5	0.000	1.000	0.349	0.050	21.500	21.500
6	0.050	0.950	0.349	0.050	21.100	21.000
7	0.000	1.000	0.332	0.130	19.500	19.500
8	0.000	1.000	0.332	0.110	19.500	19.500
9	0.050	0.950	0.332	0.170	19.500	18.500
10	0.080	0.920	0.315	0.170	19.500	18.600
11	0.000	1.000	0.290	0.200	18.000	18.000
12	0.000	1.000	0.290	0.150	18.000	18.000
13	0.000	1.000	0.290	0.230	18.000	18.000
14	0.000	1.000	0.290	0.120	17.800	17.800
15	0.000	1.000	0.290	0.170	15.100	15.100

16	0.000	1.000	0.290	0.110	15.000	15.000
17	0.000	1.000	0.290	0.140	15.000	15.000
18	0.070	0.930	0.290	0.140	14.800	14.700
19	0.080	0.920	0.270	0.210	12.800	12.600
20	0.000	1.000	0.248	0.000	11.000	11.000
21	0.000	1.000	0.248	0.140	11.000	11.000
22	0.000	1.000	0.248	0.050	11.000	11.000
23	0.000	1.000	0.248	0.100	10.800	10.800
24	0.100	0.900	0.248	0.000	10.000	9.500
25	0.110	0.890	0.223	0.060	9.000	8.700
26	0.000	1.000	0.199	0.070	8.000	8.000
27	0.000	1.000	0.199	0.130	8.000	8.000
28	0.000	1.000	0.199	0.200	8.000	8.000
29	0.000	1.000	0.199	0.260	8.000	8.000
30	0.000	1.000	0.199	0.260	7.900	7.900
31	0.000	1.000	0.199	0.150	7.000	7.000
32	0.140	0.860	0.199	0.160	7.000	6.400
33	0.000	1.000	0.171	0.090	6.000	6.000
34	0.000	1.000	0.171	0.090	6.000	6.000
35	0.000	1.000	0.171	0.090	5.700	5.700
36	0.200	0.800	0.171	0.000	5.000	4.200
37	0.000	1.000	0.137	0.000	4.000	4.000
38	0.000	1.000	0.137	0.000	3.000	3.000
39	0.000	1.000	0.137	0.000	3.000	3.000
40	0.000	1.000	0.137	0.000	3.000	3.000
41	0.000	1.000	0.137	0.000	3.000	3.000
42	0.000	1.000	0.137	0.000	3.000	3.000
43	0.000	1.000	0.137	0.000	3.000	3.000
44	0.330	0.670	0.137	0.000	3.000	2.500
45	0.000	1.000	0.092	0.260	2.000	2.000
46	0.000	1.000	0.092	0.000	1.200	1.200
47	0.000	1.000	0.092	0.000	1.000	1.000
48	0.000	1.000	0.092	0.000	1.000	1.000
49	0.000	1.000	0.092	0.000	1.000	1.000
50	0.000	1.000	0.092	0.000	1.000	1.000
51	0.000	1.000	0.092	0.000	1.000	1.000
52	0.000	1.000	0.092	0.000	1.000	1.000
53	0.000	1.000	0.092	0.000	1.000	1.000
54	0.000	1.000	0.092	0.000	1.000	1.000
55	1.000	0.000	0.092	0.000	1.000	0.500
56	1.000	0.000	0.000	0.000	0.000	0.000

30-day mortality (both sexes): 56.7% (59 of 104 neonates)

16.2.1.1.2.1.1.3 Females (Model data) Australasian studbook

r = 0.0027
lambda = 1.0027

T = 18.98
N = 7.00
N(at 20 yrs) = 7.38

"Age (x)"	"Qx"	"Px"	"lx"	"Mx"	"Vx"	"Ex"	"Risk (Qx)"	"Risk (Mx)"
0	0.600	0.400	1.000	0.000	1.429	20.347	58.000	25.400
1	0.103	0.898	0.400	0.000	2.642	35.685	22.700	22.700
2	0.053	0.948	0.359	0.000	2.876	37.655	23.300	21.800
3	0.030	0.970	0.340	0.005	3.009	38.244	22.300	22.300
4	0.010	0.990	0.330	0.023	3.074	38.010	22.500	21.800
5	0.000	1.000	0.327	0.043	3.075	37.197	21.500	21.500
6	0.000	1.000	0.327	0.065	3.040	36.197	21.100	21.000
7	0.000	1.000	0.327	0.100	2.983	35.197	19.500	19.500
8	0.012	0.988	0.327	0.135	2.909	34.412	19.500	19.500
9	0.038	0.963	0.323	0.160	2.853	34.266	19.500	18.500
10	0.038	0.963	0.310	0.170	2.805	34.562	19.500	18.600
11	0.012	0.988	0.299	0.170	2.710	34.431	18.000	18.000
12	0.000	1.000	0.295	0.170	2.563	33.642	18.000	18.000
13	0.000	1.000	0.295	0.165	2.400	32.642	18.000	18.000
14	0.000	1.000	0.295	0.153	2.241	31.642	17.800	17.800
15	0.000	1.000	0.295	0.143	2.094	30.642	15.100	15.100
16	0.000	1.000	0.295	0.140	1.956	29.642	15.000	15.000
17	0.017	0.983	0.295	0.140	1.837	28.895	15.000	15.000
18	0.053	0.948	0.290	0.140	1.763	28.902	14.800	14.700
19	0.053	0.948	0.275	0.140	1.718	29.448	12.800	12.600
20	0.017	0.983	0.260	0.130	1.640	29.494	11.000	11.000
21	0.000	1.000	0.256	0.100	1.528	28.748	11.000	11.000
22	0.000	1.000	0.256	0.070	1.432	27.748	11.000	11.000
23	0.025	0.975	0.256	0.060	1.383	27.087	10.800	10.800
24	0.075	0.925	0.249	0.060	1.395	27.451	10.000	9.500
25	0.075	0.925	0.231	0.063	1.448	28.595	9.000	8.700
26	0.025	0.975	0.213	0.083	1.463	29.078	8.000	8.000
27	0.000	1.000	0.208	0.133	1.402	28.438	8.000	8.000
28	0.000	1.000	0.208	0.198	1.273	27.438	8.000	8.000
29	0.000	1.000	0.208	0.245	1.079	26.438	8.000	8.000
30	0.000	1.000	0.208	0.235	0.836	25.438	7.900	7.900
31	0.000	1.000	0.208	0.183	0.602	24.438	7.000	7.000
32	0.000	1.000	0.208	0.138	0.421	23.438	7.000	6.400
33	0.000	1.000	0.208	0.105	0.284	22.438	6.000	6.000
34	0.000	1.000	0.208	0.090	0.180	21.438	6.000	6.000
35	0.000	1.000	0.208	0.068	0.090	20.438	5.700	5.700
36	0.000	1.000	0.208	0.023	0.023	19.438	5.000	4.200
37	0.000	1.000	0.208	0.000	0.000	18.438	4.000	4.000
38	0.000	1.000	0.208	0.000	0.000	17.438	3.000	3.000
39	0.000	1.000	0.208	0.000	0.000	16.438	3.000	3.000
40	0.000	1.000	0.208	0.000	0.000	15.438	3.000	3.000
41	0.000	1.000	0.208	0.000	0.000	14.438	3.000	3.000
42	0.000	1.000	0.208	0.000	0.000	13.438	3.000	3.000
43	0.000	1.000	0.208	0.000	0.000	12.438	3.000	3.000
44	0.000	1.000	0.208	0.000	0.000	11.438	3.000	2.500

45 0.000 1.000 0.208 0.000 0.000 10.438 2.000 2.000
46 0.000 1.000 0.208 0.000 0.000 9.437 1.200 1.200
47 0.000 1.000 0.208 0.000 0.000 8.438 1.000 1.000
48 0.000 1.000 0.208 0.000 0.000 7.438 1.000 1.000
49 0.000 1.000 0.208 0.000 0.000 6.438 1.000 1.000
50 0.000 1.000 0.208 0.000 0.000 5.438 1.000 1.000
51 0.000 1.000 0.208 0.000 0.000 4.438 1.000 1.000
52 0.000 1.000 0.208 0.000 0.000 3.438 1.000 1.000
53 0.000 1.000 0.208 0.000 0.000 2.438 1.000 1.000
54 0.250 0.750 0.208 0.000 0.000 1.643 1.000 1.000
55 0.750 0.250 0.156 0.000 0.000 1.200 1.000 0.500
56 1.000 0.000 0.039 0.000 0.000 1.000 0.000 0.000
57 1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

- ***Inbreeding report***

"Studbook #" "Sex" "Age" "Location" "% Known" "F"
1042 "F" 31 "AUCKLAND " 100.0 0.0000
1048 "M" 27 "WERRIBEE " 100.0 0.1250
1066 "M" 20 "DUBBO " 100.0 0.1250
1067 "F" 20 "DUBBO " 100.0 0.1250
1091 "F" 16 "WERRIBEE " 100.0 0.0000
1092 "F" 15 "WERRIBEE " 100.0 0.1875
1095 "F" 15 "DUBBO " 100.0 0.1875
1103 "M" 10 "DUBBO " 100.0 0.3125
1107 "F" 7 "DUBBO " 100.0 0.3125

- ***Mean kinship report***

Males						***Females***				
Stbk no.	MK	% known	Age	Location		Stbk no.	MK	% known	Age	Location
1103	0.279	100.0	10	DUBBO		1042	0.117	100.0	31	AUCKLAND
1066	0.284	100.0	20	DUBBO		1091	0.217	100.0	16	WERRIBEE
1048	0.315	100.0	27	WERRIBEE		1067	0.232	100.0	20	DUBBO
						1092	0.276	100.0	15	WERRIBEE
						1095	0.276	100.0	15	DUBBO
						1107	0.279	100.0	7	DUBBO
						1178	0.286	100.0	3	WERRIBEE

- ***Individuals used in genetic analysis***

Sbk #	Sex	Sire	Dam	Age	LOCATION	Vx	% known	F	MK	KV	GU - All	GU - Descend	Prob Lost	FOKE	# Offspring	Local ID	
1042	F	1009	1014	31	AUCKLAND	0.65	100.0	0.0000	0.1242	0.0941	0.6425	0.6425	0.2646	4.97	0	MH0175	Faith
1091	F	1048	1012	16	WERRIBEE	1.90	100.0	0.0000	0.2094	0.2180	0.2450	0.2450	0.0180	8.38	1	900222	Primrose
1067	F	1025	1029	20	DUBBO	1.57	100.0	0.1250	0.2266	0.2176	0.1275	0.1275	0.0169	9.06	1	890046	Rumbin
1095	F	1066	1067	15	DUBBO	2.06	100.0	0.1875	0.2750	0.2864	0.0000	0.0000	0.0008	11.00	0	910009	Mafuta
1092	F	1048	1057	15	WERRIBEE	2.06	100.0	0.1875	0.2781	0.2890	0.0810	0.0810	0.0054	11.13	0	900248	Brindabella
1066	M	T1035	1037	20	DUBBO	3.95	100.0	0.1250	0.2797	0.3181	0.0400	0.0400	0.0002	11.19	1	850026	Happy2
1178	F	1048	1091	3	WERRIBEE	2.77	100.0	0.2813	0.2836	0.3053	0.0000	0.0000	0.0004	11.34	0	A30001	Tulip
1103	M	1080	1037	10	DUBBO	3.52	100.0	0.3125	0.2859	0.3295	0.0455	0.0455	0.0003	11.44	0	960041	Mana
1107	F	1080	1037	7	DUBBO	2.93	100.0	0.3125	0.2859	0.3238	0.0360	0.0360	0.0007	11.44	0	990147	Nile
1048	M	T1035	1037	27	WERRIBEE	3.01	100.0	0.1250	0.3109	0.3395	0.0075	0.0075	0.0002	12.44	3	840004	Harold

- ***Studbook printout***

16.2.1.1.2.1.2

16.2.1.1.2.1.3 COMMON HIPPOPOTAMUS Studbook 1

16.2.1.1.2.1.4 Restricted to: (Hippopotamus amphibius)

16.2.1.1.2.1.5 Locations: AUSTRALAS/

16.2.1.1.2.1.6 Dates: Between 27/02/2006 and 28/02/2006

16.2.1.1.2.1.7 Status: Living during 27 Feb 2006 -> 28 Feb 2006

16.2.1.1.2.1.8 ==========

16.2.1.1.2.1.9 Stud # | Sex | Birth Date | Sire | Dam | Location | Date | Local ID | Event |Rearing|Name |Transponder # |

16.2.1.1.2.1.10 ==========

16.2.1.1.2.1.11

16.2.1.1.2.1.12	1017	F	14 Oct 1959	1009	UNK	AUCKLAND	14 Oct 1959	MH0159	Birth	Parent	SNORKEL	
16.2.1.1.2.1.13												
16.2.1.1.2.1.14	1025	M	18 May 1965	1010	1006	SYDNEY	18 May 1965	650018	Birth	Parent	ALBERT	
16.2.1.1.2.1.15						BRISBANE	9 May 1969	UNK	Transfer			
16.2.1.1.2.1.16						ADELAIDE	3 Jan 1975	750020	Transfer			
16.2.1.1.2.1.17												
16.2.1.1.2.1.18	1029	F	30 Dec 1967	1010	1008	SYDNEY	30 Dec 1967	670023	Birth	Parent	SUSIE	

16.2.1.1.2.1.19						BRISBANE	30 Apr 1969	UNK	Transfer			
16.2.1.1.2.1.20						ADELAIDE	3 Jan 1975	750021	Transfer			
16.2.1.1.2.1.21												
16.2.1.1.2.1.22	1037	F	26 Mar 1970	1010	1008	SYDNEY	26 Mar 1970	700054	Birth	Parent	SUZIE	
16.2.1.1.2.1.23						DUBBO	8 Apr 1976	760005	Transfer			
16.2.1.1.2.1.24												
16.2.1.1.2.1.25	1042	F	5 Jan 1975	1009	1014	AUCKLAND	5 Jan 1975	MH0175	Birth	Parent	FAITH	
16.2.1.1.2.1.26												
16.2.1.1.2.1.27	1048	M	7 Mar 1978	1121	1037	DUBBO	7 Mar 1978	780003	Birth	Parent	HAROLD	
16.2.1.1.2.1.28						WERRIBEE	30 Oct 1984	840004	Transfer			
16.2.1.1.2.1.29												
16.2.1.1.2.1.30	1066	M	24 Dec 1985	1121	1037	DUBBO	24 Dec 1985	850026	Birth	Parent	HAPPY2	
16.2.1.1.2.1.31												
16.2.1.1.2.1.32	1067	F	22 Feb 1986	1025	1029	ADELAIDE	22 Feb 1986	860133	Birth	Parent	RUMBIN	
16.2.1.1.2.1.33						DUBBO	20 Oct 1989	890046	Transfer			
16.2.1.1.2.1.34												
16.2.1.1.2.1.35	1076	m	16 Mar 1988	1009	1042	AUCKLAND	16 Mar 1988	MH0188	Birth	Parent	FUDGE	
16.2.1.1.2.1.36												
16.2.1.1.2.1.37	1091	F	1 Dec 1990	1048	1012	WERRIBEE	1 Dec 1990	900222	Birth	Parent	PRIMROSE	
16.2.1.1.2.1.38												

16.2.1.1.2.1.39	1092	F	9 Dec 1990	1048	1057	WERRIBEE	9 Dec 1990	900248	Birth	Parent	BRINDABELL			
16.2.1.1.2.1.40														
16.2.1.1.2.1.41	1095	F	18 Mar 1991	1066	1067	DUBBO	18 Mar 1991	910009	Birth	Parent	MAFUTA			
16.2.1.1.2.1.42														
16.2.1.1.2.1.43	1103	M	31 Mar 1996	1080	1037	DUBBO	31 Mar 1996	960041	Birth	Parent	MANA	00-061F-11D4		
16.2.1.1.2.1.44														
16.2.1.1.2.1.45	1107	F	15 May 1999	1080	1037	DUBBO	15 May 1999	990147	Birth	Parent	NILE			
16.2.1.1.2.1.46														
16.2.1.1.2.1.47	1135	F	12 Mar 1982	1121	1037	DUBBO	12 Mar 1982	820029	Birth	Parent	DAISY			
16.2.1.1.2.1.48						TIPP STAT	13 Oct 1989	_____	Transfer					
16.2.1.1.2.1.49						MAREEBA	28 Sep 2004	_____	Transfer					
16.2.1.1.2.1.50														
16.2.1.1.2.1.51	1144	F	13 Mar 1987	1009	1017	AUCKLAND	13 Mar 1987	MH0187	Birth	Parent	SOLUCKY			
16.2.1.1.2.1.52						TIPP STAT	10 Mar 1988	870006	Transfer					
16.2.1.1.2.1.53						MAREEBA	28 Sep 2004	HA0001	Transfer					
16.2.1.1.2.1.54														
16.2.1.1.2.1.55	1178	F	1 Jan 2003	1048	1091	WERRIBEE	1 Jan 2003	A30001	Birth	Parent	TULIP			
16.2.1.1.2.1.56														
16.2.1.1.2.1.57	1179	M	~ Nov 2003	1143	1135	TIPP STAT	~ Nov 2003	_____	Birth	Parent				

16.2.1.1.2.1.58 MAREEBA 28 Sep 2004 _____ Transfer

16.2.1.1.2.1.59 ==========

16.2.1.1.2.1.60 TOTALS: 6.12.0 (18)

16.2.1.1.2.1.61

16.2.1.1.2.1.62

16.2.1.1.2.1.63 Compiled by: Suzy Barlow thru Melbourne Zoo

16.2.1.1.2.1.64 Data current thru: 8 Feb 2006 Australasia

16.2.1.1.2.1.65 Printed on 1 Mar 2006 using Sparks v1.52

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APPENDIX 4

Hippo Behaviour Check Sheet

Date:	**Start Time:**				**Volunteer's Name:**							
Behaviour	**5 mins**	**10 mins**	**15 mins**	**20 mins**	**25 mins**	**30 mins**	**35 mins**	**40 mins**	**45 mins**	**50 mins**	**55 mins**	**60 mins**
Sniffing												
Urine Testing												
Wheeze-honking												
Yawning												
Water-scooping												
Explosive exhalation												
Facing aggressor mouth open												
Lying prone												
Chasing and flight												
Porpoising												
Roaring and grunting												
Dung-showering												
Anti-predator behaviour												
Courtship displays												

Fighting												
Behaviour	**5 mins**	**10 mins**	**15 mins**	**20 mins**	**25 mins**	**30 mins**	**35 mins**	**40 mins**	**45 mins**	**50 mins**	**55 mins**	**60 mins**
Mating												
Grazing												
Submerged												
Sleeping												
Feed/Drink												
Comments												

Instructions**:** Watch Hippos continually for 5 minutes. Mark behaviours with an M if Happy did the behaviour and an F if the behaviour was done by Rumbin . Put a mark for every behaviour that occurs. e.g.. 3 M's for "Yawning" if Happy yawns 3 times during a 5 minute period. For behaviours occurring for longer durations write the number of minutes over the 5 minute period the behaviour was observed (maximum 5 mins) eg. If Rumbin is observed grazing for 3 minutes out of the 5 minute interval write R 3 mins. After 5 minutes, move to a new column and repeat as described above.